Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

410 EMPIRE BUILDING — March, 1945 — PITTSBURGH, PA.

Mounting slabbing mill rolls on anti-friction bearings represents one of the greatest advancements ever to be made in this type of equipment; perhaps the most important advancement ever made in slabbing mills.

At the present time there is only ✱ one slabbing mill in the country equipped with anti-friction bearings on the roll necks—and that one is equipped with Timken Roll Neck Bearings. It is operating in the Pittsburgh district. The Timken Bearings used on the roll necks have a separating force capacity of 5,000,000 lbs. at mill speed.

What Timken Roll Neck Bearings have done for strip mills, plate mills, piercing mills and slabbing mills they can do for *blooming mills.* It will pay you to give this careful consideration, whether you are thinking of buying a new blooming mill or modernizing an existing one. The Timken Roller Bearing Company, Canton 6, Ohio.

✱ See page 35

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Advantages of Timken Bearing Equipped Slabbing Mills
- Greater Tonnage
- Maintenance of Slab Size
- Less Scrap
- Power Saving
- Lubrication Economy
- Reduced Maintenance

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DETROIT

WHEN MOTOR CONTROL IS UNITROL

Reg. U. S. Pat. Office

YOU'RE READY FOR THE SHIFT

At times like these when plant executives must be ready on a moment's notice to shift plant facilities from one type of production to another, you're lucky if your Motor Control is UNITROL. This newest of all forward steps in Motor Control equipment pioneered by Cutler-Hammer Engineers, gathers up controls scattered throughout a plant, concentrates them into one compact centralized unit that makes room for *more* control, *more* machines, *more* operations. UNITROL houses all the control within the space of a few steps and lightens the labor of servicing and inspection. UNITROL requires no costly building, no costly wall or floor preparation, now or later.

And above all, UNITROL makes possible the easiest, speediest and least costly rearrangement and reorganization of production equipment. Only machines, not the control, need be relocated. The individual control units can be changed at will, sections added, taken away or rearranged like the filing cabinet sections in your office.

Take advantage of today's opportunity to modernize your control equipment by replacing it with UNITROL and be ready for the shift, any shift now or in the future. Let a Cutler-Hammer engineer survey your requirements. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
UNITROL
C-H

Engineering excellence finds its greatest reward in the respect and confidence of those it serves

Simple way t
house motor co

The control is mounted in a U
Door Frame.

The door frame is mounted in
TROL Section.

Sections are grouped togeth
joined.

Presto! you have a complete, c
plant-serving Motor Control
ready for any need to co

ANOTHER PRODUCT OF AETNA•STANDARD

ROLLS

There is an Aetna-Standard size and type of Roll for every purpose . . . .

Sizes . . . from rolls for an 8-inch mill, all intermediate sizes, up to large plate mill rolls, 34" x 206".

Plain Chill	Special Alanite
Moly Chill	Grain
Nickel Chill	Asex
Alanite	Asex Special

Forming, welding, and sizing Rolls for steel pipe, rolls for rubber and plastic mills.

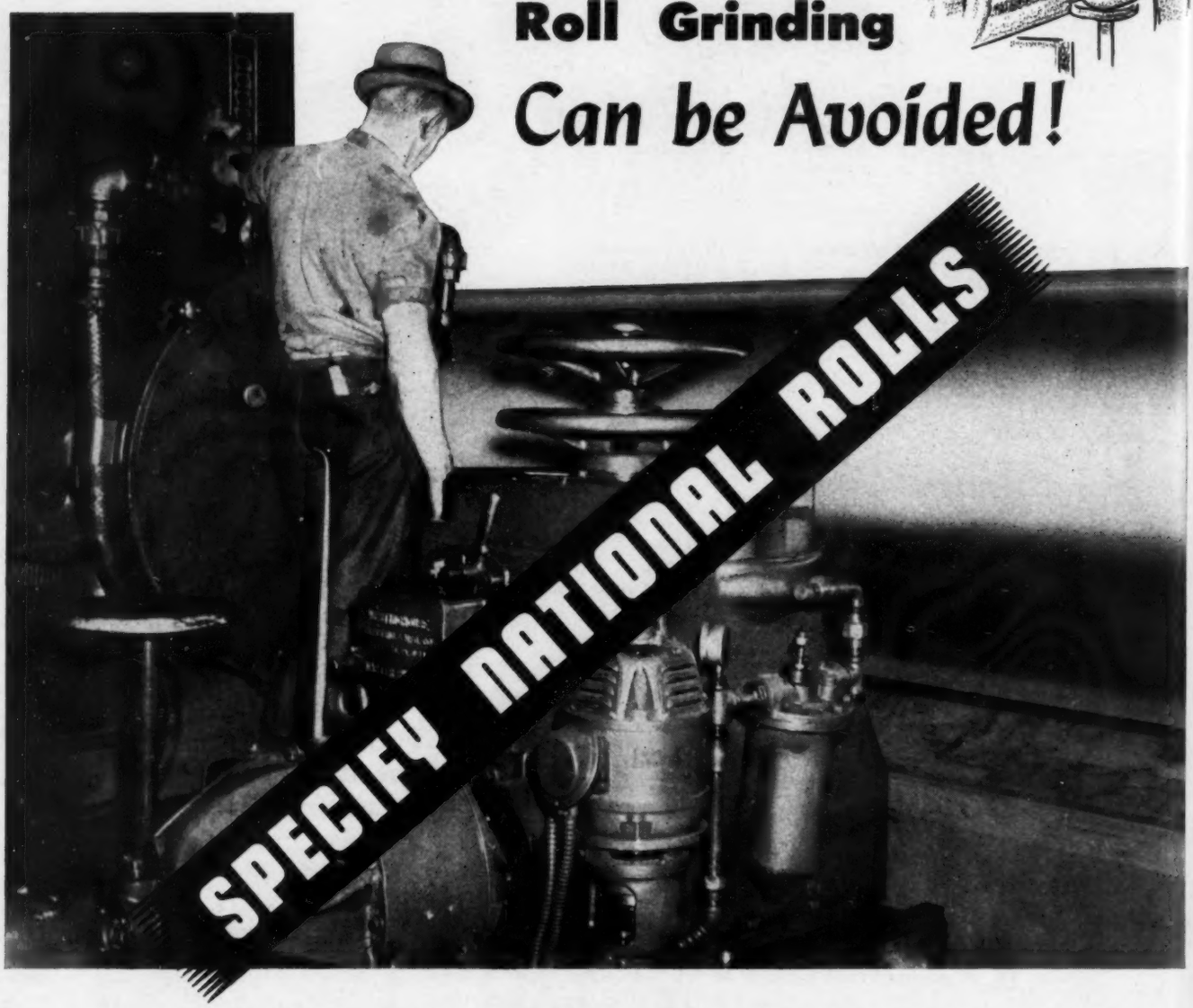
THE AETNA•STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Taking excessive time out for Roll Grinding Can be Avoided!



NATIONAL ROLLS

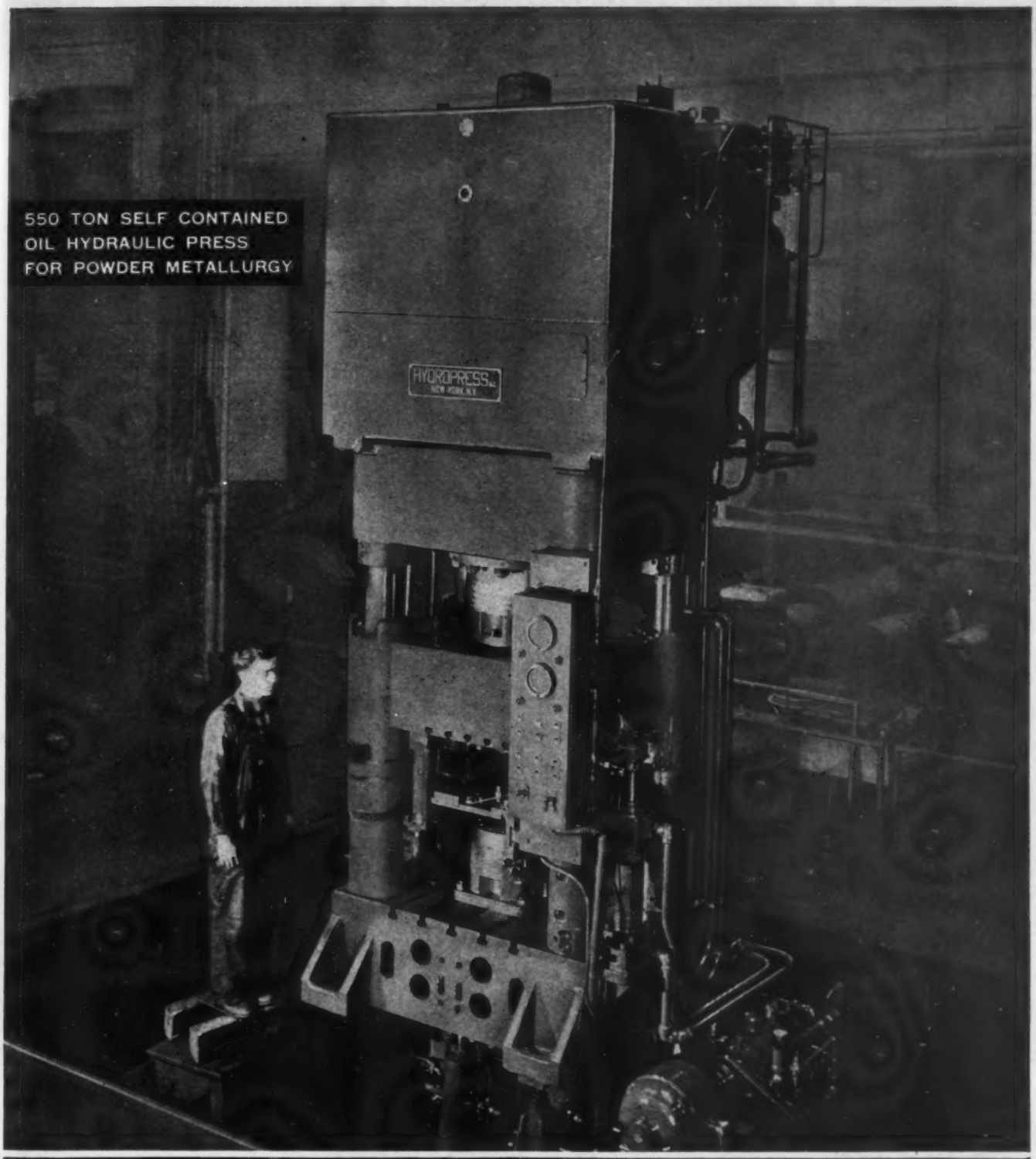
* War has no Sundays and 'round-the-clock duty for rolling mill equipment is a today's "must". Frequent shut-downs for roll changes stymie production, increase costs and seriously reduce vital tonnage.

Today, mill operators rightfully expect more roll service between grinds. National Rolls fulfill this expectation. Correct metallurgical composition, uniform casting and precision finishing have been combined to provide maximum strength and durability. Rolls bearing the National name are highly regarded by roll users everywhere.

NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

Manufacturers of: ALL GRADES OF CAST ROLLS • IRON & ALLOY IRON STEEL & ALLOY STEEL • HEAVY IRON & STEEL CASTINGS • ROLLING MILL EQUIPMENT



HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N Y

NEW GIANT GANTRY CRANES BY Alliance

NGINEERING DATA ON
IE GIANT GANTRY CRANE

SPAN—90'

LOAD—270 TONS

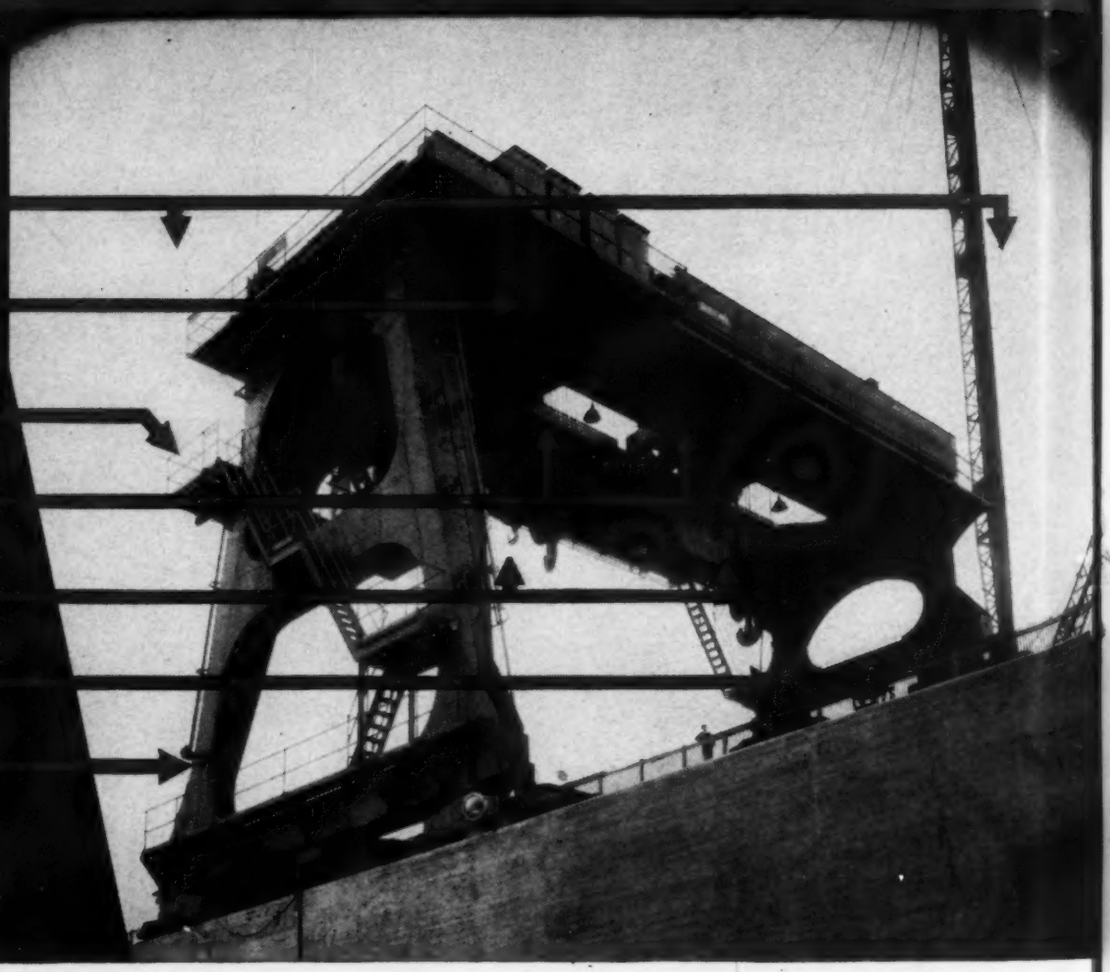
SY ACCESSIBILITY TO ALL PARTS OF
E CRANE BY MEANS OF STAIRWAYS

2 TROLLEYS—EACH 135 TONS

UXILIARY HOISTS—EACH 20 TONS

SHORT LEG—16'

LONG LEG—44'



To keep millions of kilowatts flowing from the Joe Wheeler Dam of TVA requires gigantic water wheel generators.

To keep these powerful generators humming, huge turbines and many other massive parts have to be moved back and forth along the dam. Hoisting speeds must be controlled with split-inch accuracy, so the ponderous parts can be inched into place if necessary.

This 270-ton Alliance gantry crane, recently installed, combines sturdy, unusual construction with beauty of design. It has alternating current motors and controls, and each hoist has mechanical brakes. This combination, by actual tests, enables the operator to raise or lower the full rated loads of 270 tons, in increments of one-eighth of an inch, a tremendous engineering achievement.

Alliance, world's largest builders of the world's largest cranes, can give you experienced assistance on load problems. Changes in production may require the relocating of some of your cranes. Usually, in such instances, we can adapt your present cranes to the new locations by increasing or decreasing the spans. Check with The Alliance Machine Company for cost-saving recommendations.

★

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES
★ OPEN HEARTH CHARGING MACHINES ★

ARMY E NAVY

THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

PITTSBURGH OFFICE : 1622 OLIVER BUILDING

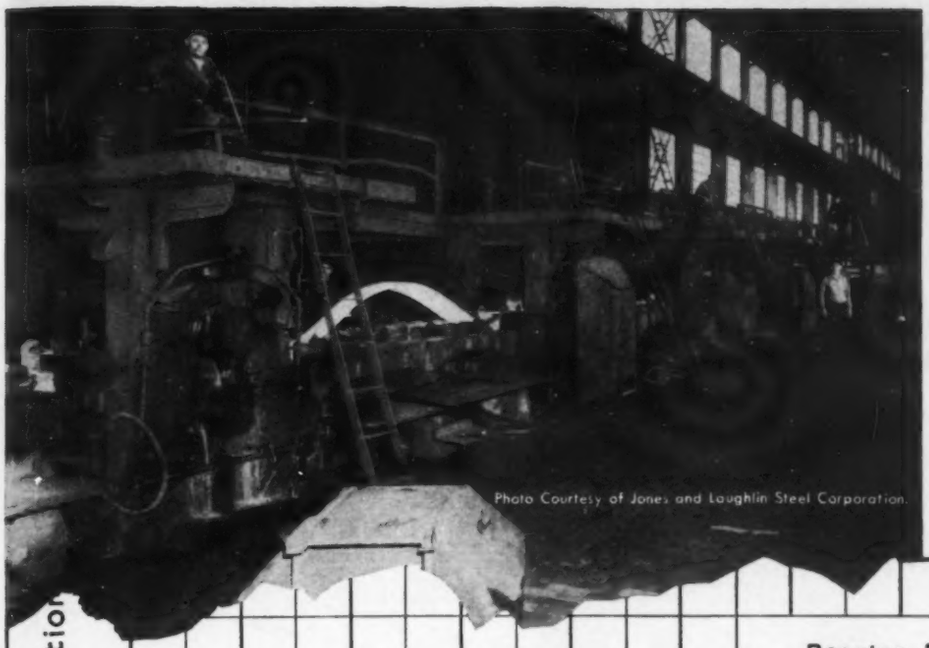
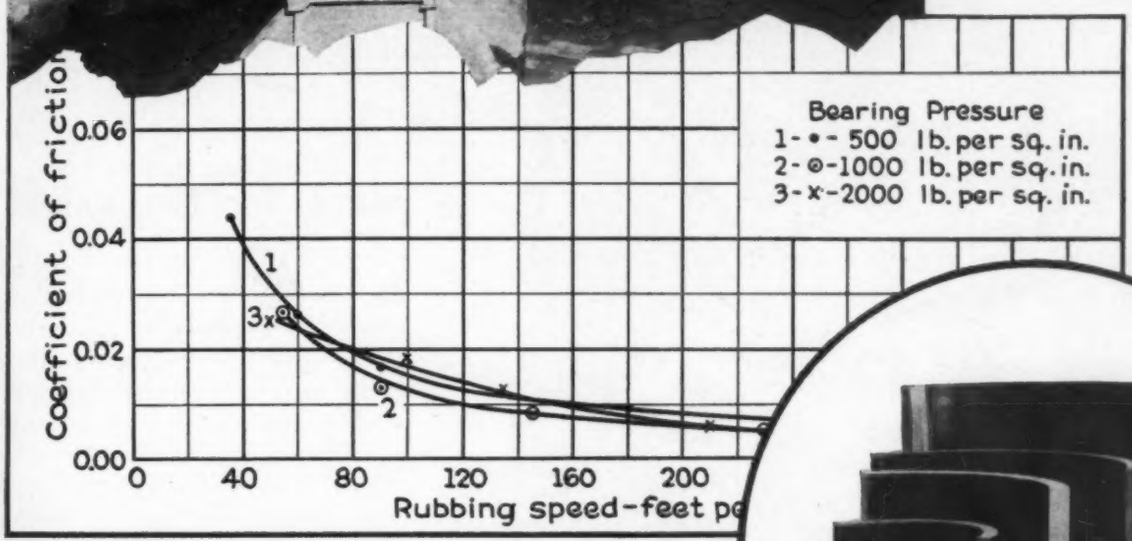
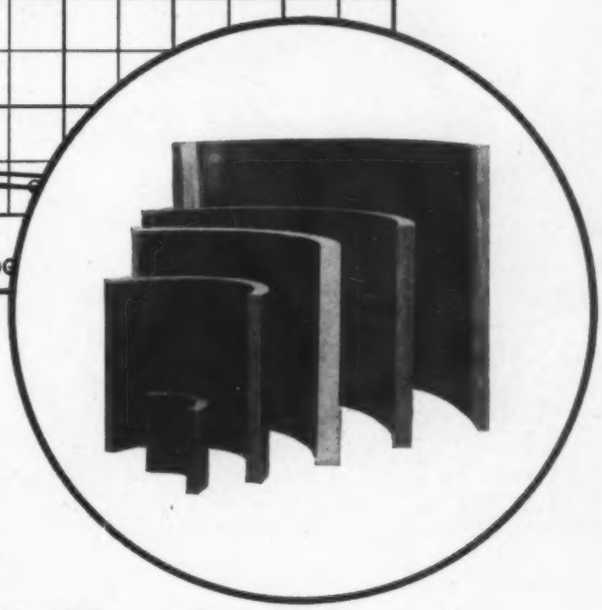


Photo Courtesy of Jones and Laughlin Steel Corporation.





Jones and Laughlin Steel Corporation Uses G-E Roll-Neck Bearings

Jones and Laughlin Steel Corporation's 30″ Hot Strip mill in Cleveland, Ohio, uses G-E Textolite roll-neck bearings because of their economy.

Simple water lubrication reduces material and labor costs, provides a cleaner operation. Low friction losses mean power economy and keep necks cool to prevent fire cracks. Increased life minimizes number of bearing changes and adjustments—cuts down-time. For further information write section W-68, One Plastics Avenue, Pittsfield, Mass.

Hear the General Electric Radio Programs: "The G-E All-Girl Orchestra," Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

GENERAL ELECTRIC

PD-68

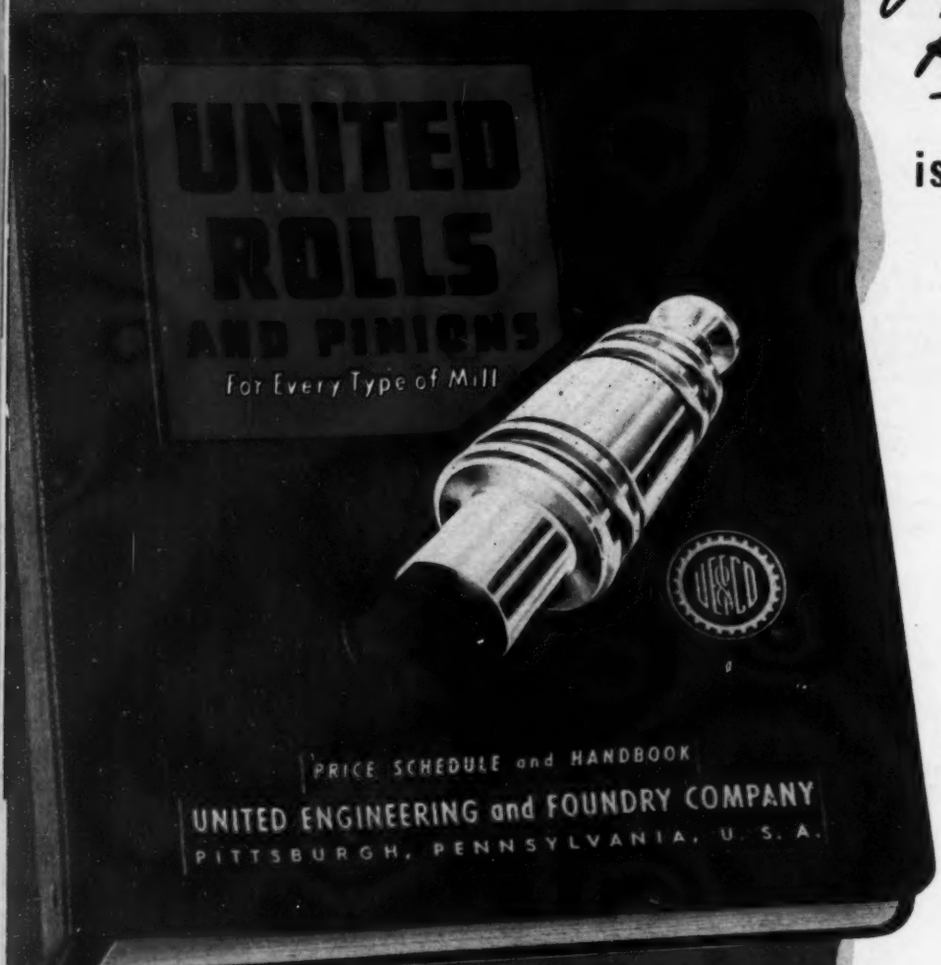
Buy and Save War Bonds

Now Ready

This New Catalog and Handbook

for the Rolling Industry

is yours for the asking



Just off the press. It's new, authoritative, up-to-the-minute. And it's packed with authentic technical and metallurgical information for those engaged in the rolling of ferrous or non-ferrous metals or other materials. The various types of rolls most successfully used in today's modern rolling operations are fully described.

It lists and illustrates the 15 principal classifications of rolls manufactured by United Engineering and Foundry Company, together with the necessary data, grade designations, and prices to make selection of the right roll for your particular requirement easy and positive. And there is a complete section devoted exclusively to tables and charts packed with information valuable to users of rolls in every industry.

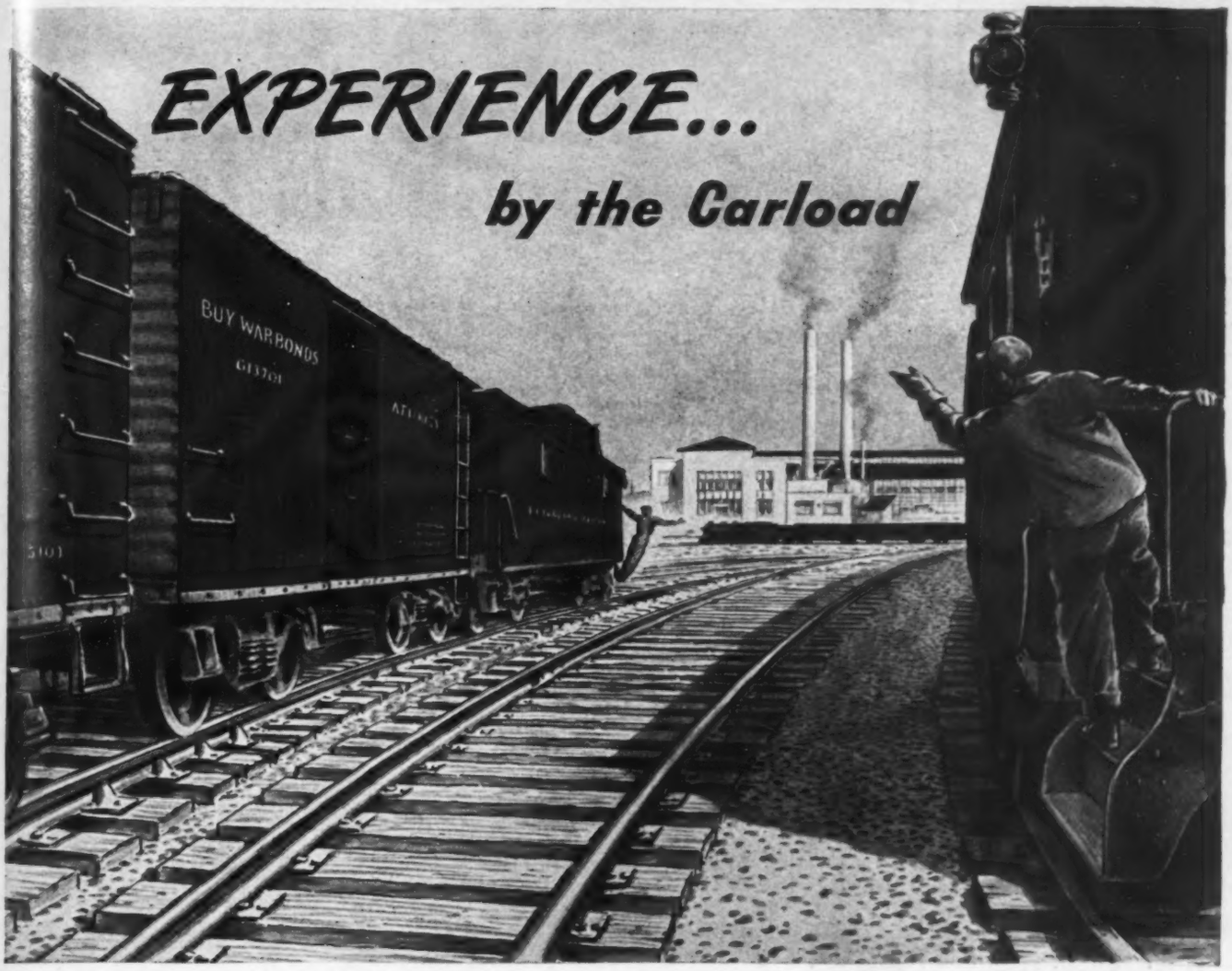
The edition is limited. So better mail your request today!

There's a UNITED ROLL for every Rolling Requirement

UNITED ENGINEERING and FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA
Plants at PITTSBURGH, VANDERGRIFT, NEW CASTLE, YOUNGSTOWN, CANTON
Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q., Canada
Adamson United Company, Akron, Ohio

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

Number 8 of a Series: "Looking at the 5 essential things you never see in electrodes!"



SIXTY YEARS of accumulated manufacturing experience taught us exactly what materials make the best electric-furnace electrodes. Experience guides the minds, hands and machines within National Carbon plants.

That's why "Experience . . . by the carload!" aptly describes the flow of raw materials and finished electrodes in and out of National Carbon Company plants.

Manufacturing experience has helped to nearly cut in half the price of "Acheson" graphite electrodes in twenty years. "National" carbon electrode prices have also been greatly lowered. Yet you have continued to get stronger, more uniform electrodes of higher current capacity . . . and ever-lower cost per ton of electric-furnace output.

A complete explanation of this steady improvement in product performance lies in all five of the *essential things you never see,* but which are present, in every "National" and "Acheson" electrode: Manufacturing experience, selection of raw materials, continuing research, manufacturing control, and customer service.

NATIONAL CARBON

ACHESON GRAPHITE

The words "National" and "Acheson" and the "National" and "Acheson" Seals are registered trade-marks of National Carbon Company, Inc.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
GENERAL OFFICES: 30 East 42nd Street, New York 17, N.Y.
DIVISION SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: Canadian National Carbon Company Limited, Welland, Ontario

KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

3 tested methods for...

CHOOSE THE ONE BEST SUITED TO YOUR NEEDS

Accurate control of electrode position—that's the key to efficient arc furnace operation—and *that's fundamental.* To obtain this, it is necessary to control the electrode position by the relation between arc current and arc voltage—and that's fundamental, too. This is a Westinghouse development, proved by more than 20 years' use.

Westinghouse has 3 tested-in-use types of electrode control—all operating on this basic principle. *No other manufacturer can offer you this wide a choice.* For complete *unbiased* advice on which type is best suited to your needs, call your nearest Westinghouse representative. Westinghouse Electric & Mfg. Co., P. O. Box 868, Pittsburgh 30, Pa.

J-94657

Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

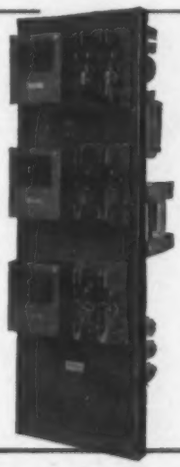
. . Arc Furnace Control

ONLY WESTINGHOUSE CAN OFFER YOU THIS TRIPLE CHOICE

1 BALANCED BEAM REGULATOR

First of the three Westinghouse-perfected methods of electrode control, this regulator may be adapted to any arc furnace equipped with motor-operated electrodes. It applies full d-c voltage to the electrode motors in a series of impulses as established by a mechanical balance of arc current against arc voltage through a beam arrangement.

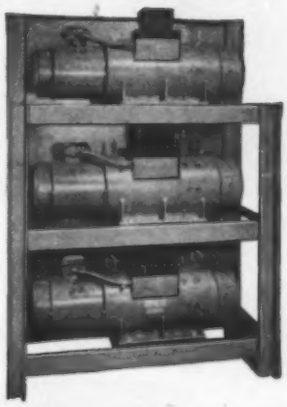
This pioneering method of electrode control became an industry standard, proved in use by more than twenty years of successful application. Its introduction was the first demonstrated proof of the principle, discovered by Westinghouse, that automatic electrode control reduces carbon absorption to a minimum.



2 ROTOTROL

This method of control provides extremely smooth, positive and rapid operation—applying variable voltage to the electrode motors without the use of reversing switches or contactors. The entire control is accomplished by a few simple, substantial devices. A minimum of external connections are required. Plug-in type of individual ROTOTROL units permits immediate replacement. Enclosed construction gives protection from dirt and physical damage.

The principle of ROTOTROL has been proved through more than twenty years of diversified applications in many industries. This latest use, for arc furnace electrode positioning, is based on the knowledge gained through successful adaptations in the welding, mining, machine tool—and many other fields.

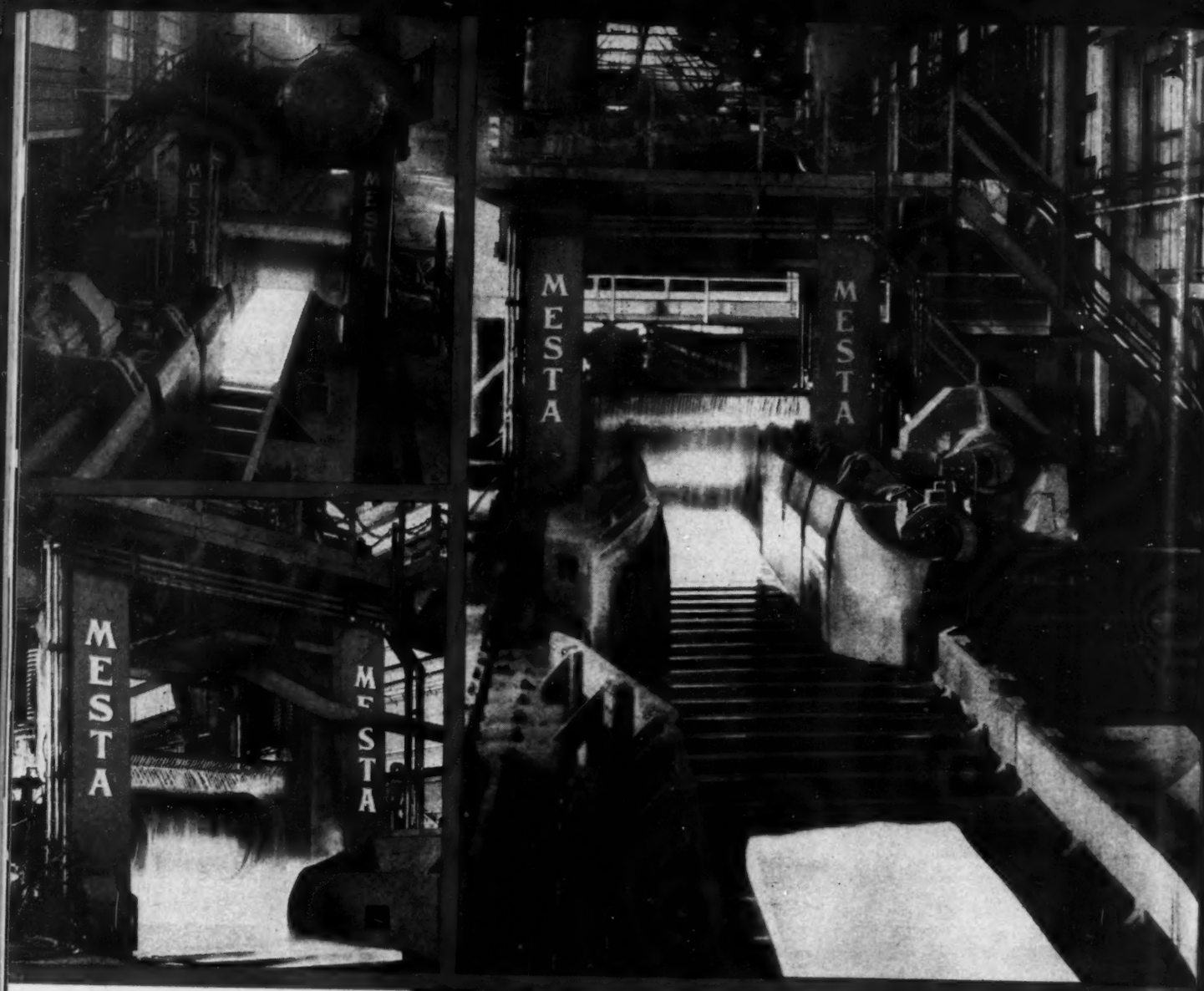


3 ELECTRONIC REGULATOR

For electrode motors of smaller size, this unit offers outstanding advantages. There are almost no moving parts to wear or get out of adjustment. Operation is fully automatic. Response characteristics are adjustable, to suit the needs of the individual application. No separate direct current supply is needed for the electrode motors; the rectifying action of Thyratron tubes meets the needs of the armature; the Rectox rectifier, the field.

In this new electronic regulator, smoothness of operation and accuracy of control are matched by simplicity of installation and economy of space—for sustained, trouble-free service. The assembly consists of standard electronic units, using popular-priced, low-current tubes, conservatively applied for long life.

ELECTRICAL PARTNER OF THE STEEL INDUSTRY



Complete

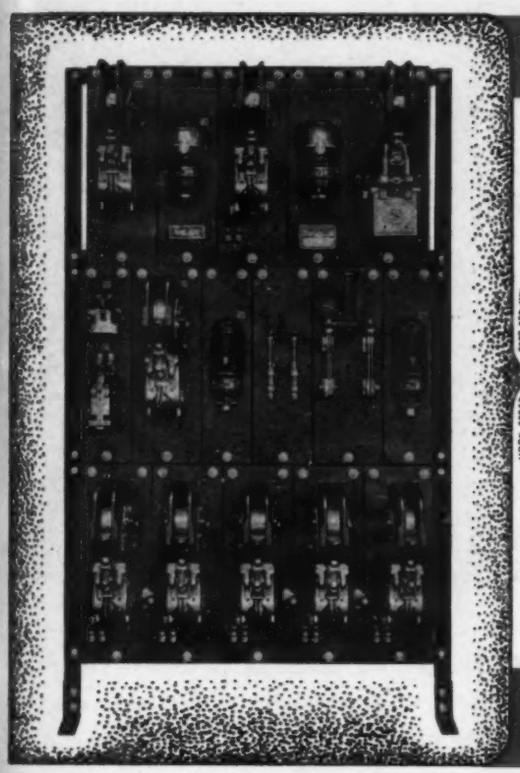
SLABBING MILL INSTALLATIONS are designed and built by

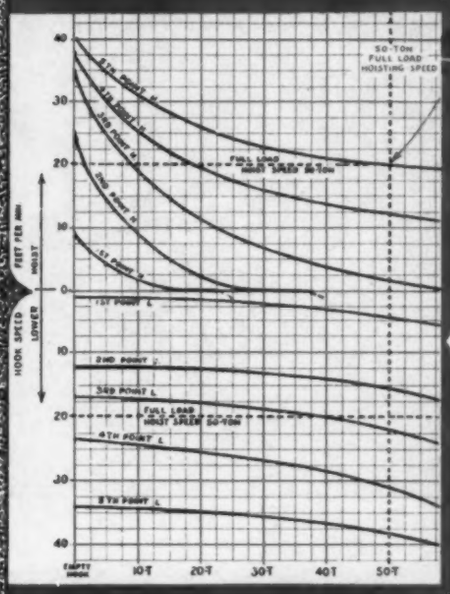
MESTA

ARMY E NAVY

MESTA MACHINE CO. . . . . PITTSBURGH, PA.

EC&M MAGNETIC Hoist Control... Assures IMPROVED Crane OPERATION



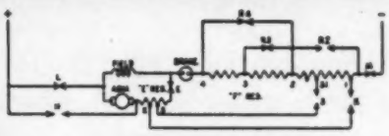


MORE TRIPS PER MINUTE

The compact Master Switch requires small space in the front of the operator. The control panel may be mounted at rear of cage or along bridge walkway.

Light loads or the empty hook lower at high speed as shown by the bottom curve at left. Also, operator has complete control of the load in lowering—brake sets immediately at the off point and, with dynamic braking assistance, brings the load to rest quickly. This results in fast operation and high output.

Performance curve of 50-ton crane-hoist operated by 90 H.P. motor. Crane efficiency—80%



Quick Response because Brake Releases Instantly

All the current taken from the line on first point lowering goes through the brake coil, as shown in the above connection-diagram—an exclusive feature. This gives fast brake release, reduces number of controller-movements to spot a load—means less wear, too.

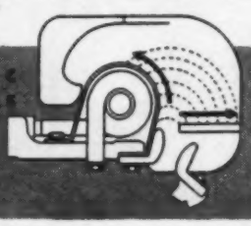
Line-arcs are Noted for Low Up-keep

Contacts operate cooler, last longer, because as they start to separate, the arc is immediately transferred from contact tips to arcing-plate and circular blow-out guard. Here it is centered between but not touching the arc shields—hence, no destructive burning of shields.

IT gives high output per crane-hour meaning a swift, steady flow of materials. It operates with exceptional smoothness . . . responds fast, accurately, aiding operator, especially, in spotting heavy loads.

Yet—besides all these advantages, EC&M Magnetic Control is noted for its low upkeep and easy maintenance. Many plants are replacing manual control on their d.c. cranes with this EC&M Wright Dynamic Lowering Circuit type.

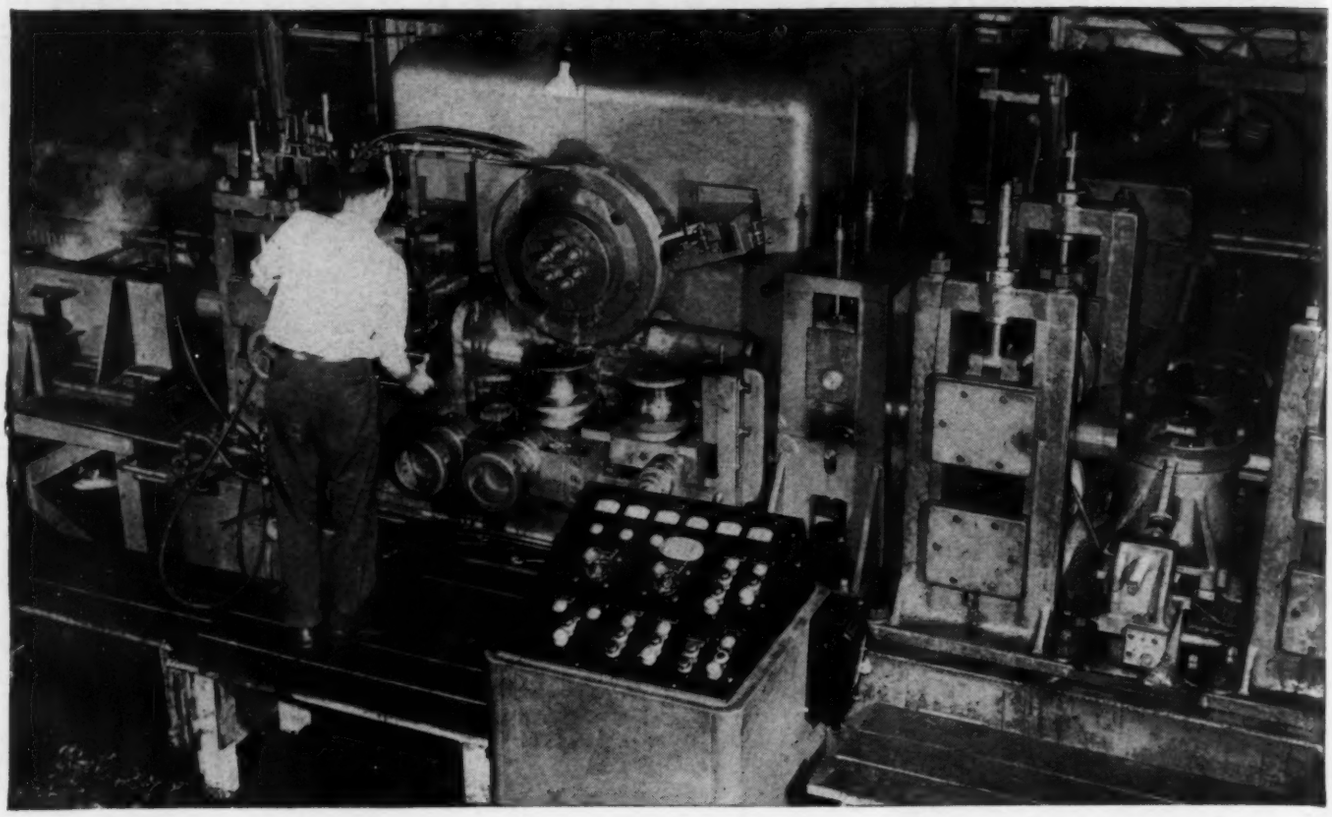
Complete details are in Bulletin 921. Ask for copy.



THE ELECTRIC CONTROLLER AND MANUFACTURING CO.

2698 EAST 79TH STREET CLEVELAND 4, OHIO

High Production Pipe Mills by YODER



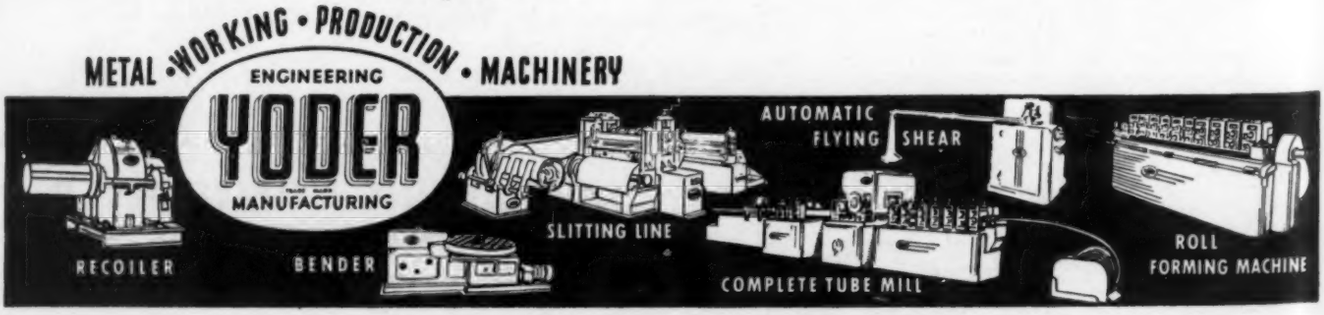
The Quantity of pipe produced by the YODER 6″ cold-forming, resistance weld pipe mill shown above is measured in miles per shift, without hardship on the crew. Other YODER mills, proportionately productive, have capacities from 24 inches down to ½ inch (pipe gauges) or ¼ inch (tube gauges).

The Quality... of pipe, produced on YODER mills, it's workability, flexibility and strength, are illustrated in some measure by the pieces pictured at left, which have been hydrostatically tested, flanged, telescoped and compressed. Your own tests would further prove this quality.

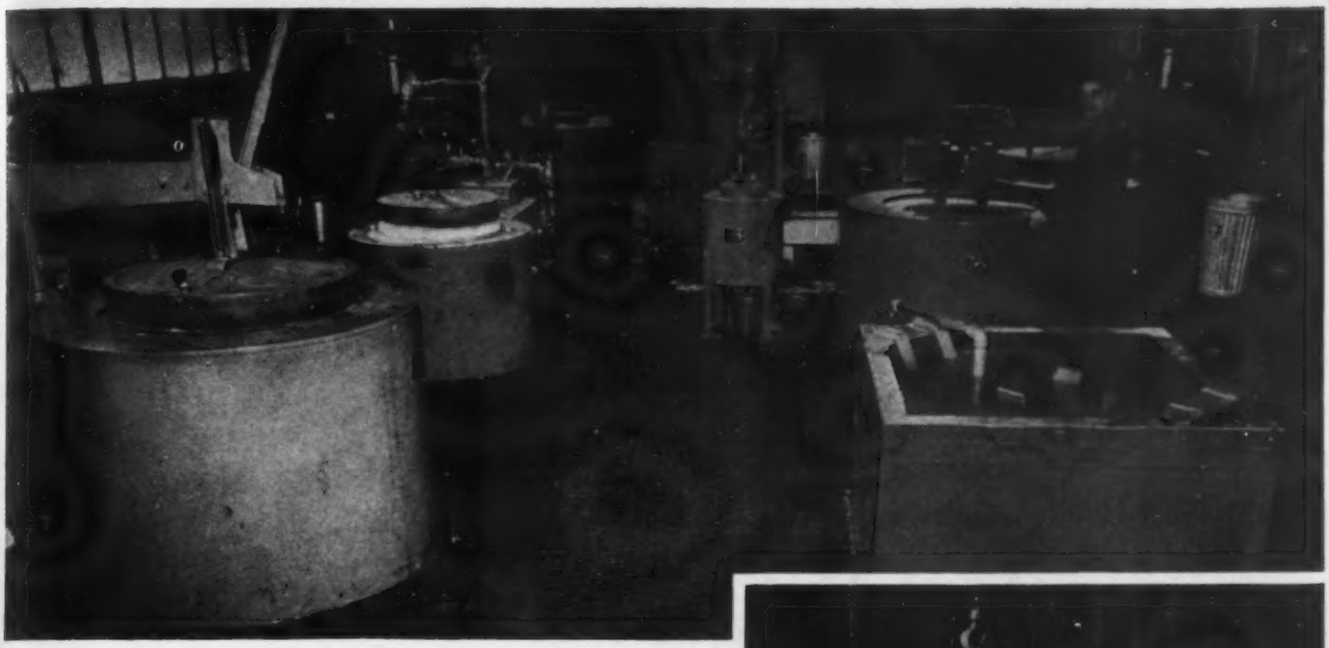
The Cost of tube and pipe production on YODER mills is provably low. Quality produced in quantity without waste of man-hours on "down time" naturally results in minimum cost per saleable unit.

YODER makes many kinds of metal working equipment. Let us give you full particulars.

METAL • WORKING • PRODUCTION • MACHINERY



5526 WALWORTH AVE., CLEVELAND 2, OHIO



General view of heat-treat department, Tube-Reducing Corp., Wellington, N. J. A Rockrite die, used in cold-reduction of the company's "Rockrite" tubing, is being lowered into one of the four big Vapocarb-Hump hardening furnaces.

Heavy Production of

DIES AND MANDRELS

Uses Vapocarb-Hump Hardening

Heat-treatment of tube-reducing dies and mandrels is in many ways a production job, rather than a series of tool-room problems, in Tube-Reducing Corp's plant. Jigs and fixtures standardize the placing and handling of the large numbers of tools in the furnaces and quench. Records of performance are guides in maintaining standard procedures, and, wherever possible, all controls are automatic.

A central factor in securing uniformity plus automatic control is use of the Vapocarb-Hump Method for hardening. Four large Vapocarb-Hump furnaces assure the same protective atmosphere for all dies and mandrels, so that pitting and scaling are equally prevented. The Micromax recording controllers, each with its two sensitive, carefully-placed thermocouples, show temperatures of both dies and furnace walls and enable heating to be held to any desired rate or soak point. Micromax records are easy to inter-compare, and results obtained in one furnace can be duplicated in any other.

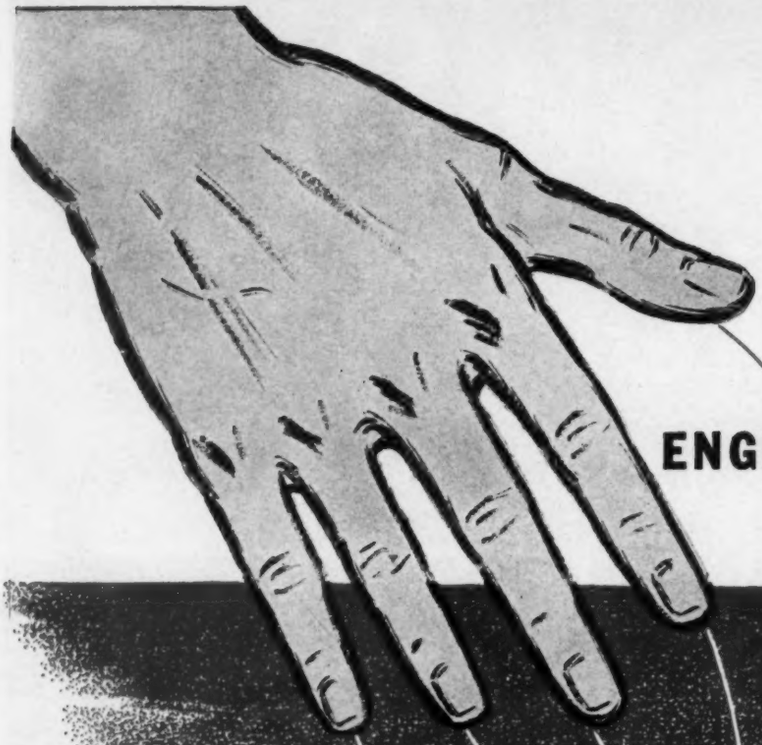
Our compact, well-illustrated Catalog T-621 gives a complete words-and-pictures description of the Vapocarb-Hump equipment and the results it is helping users secure. A copy is free on request.

Jrl. Ad T-621(33)

Close-up of operation shown at top of page; Rockrite die, made of SAE 52100 chromium steel, is cradled in special furnace fixture; and will be lowered into Vapocarb-Hump furnace for automatically-controlled heating, at specified rate, in Vapocarb protective atmosphere. Quenched on a falling temperature, it will have a Rockwell "C" hardness of 60 to 62, with uniformly smooth surface.

depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES



AT YOUR

ENGINEERED ANSWERS TO

For maximum production ... top efficiency ... lowest operating cost, give your machines the finest in lubricants—Tycol oils and greases. Tycol lubricants are made to meet every lubrication need of industry — from roll neck greases for steel mills to spindle oils for textile plants. Each Tycol lubricant is scientifically engineered to meet specific service conditions. At every step from selection of crudes to blending of the finished product, Tycol lubricants are processed to provide maximum lubricating efficiency which means greater economy, longer machine life for every type of equipment.

Tide Water engineers are thoroughly experienced in all phases of industrial lubrication. They will be glad to assist you in selecting the Tycol lubricant best suited to your specific need. Call or write your nearest Tide Water Associated office for further details.

TIDE WATER ASSOCIATED OIL COMPANY

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL • Eastern Division: 17 Battery Place, New York 4, N. Y.
Principal Branch Offices: Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

Have You Received Your Copy of "Lubricania"?

This informative handbook, "Tide Water Associated Lubricania", gives clear, concise descriptions of the basic tests used to determine important lubricant properties — Viscosity, Pour Points, Neutralization Number and many others. For your free copy write to Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

DRUMS! DRUMS! DRUMS!

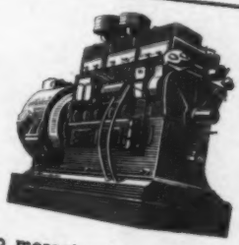
War needs make it extremely important that all empty drums be returned immediately

TYCOL
SCIENTIFICALLY

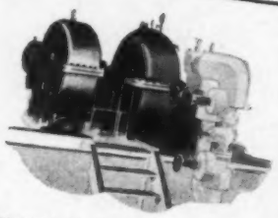
...Fingertips

EVERY LUBRICATION NEED

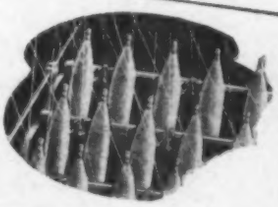
"We saved 33⅓% in oil costs when we changed to Tide Water E. A. Cylinder Oil." That report from a plant engineer typifies the kind of economical, trouble-free lubrication provided by Tide Water Steam Cylinder Oil in hundreds of plants. It gives better protection, promotes efficient operation and lowers lubrication costs.



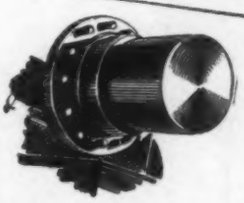
"No more trouble with sticking valves . . . costly delays and overhauls eliminated . . . engines giving better service . . ." — that's how one plant engineer describes the improved results gained with Tide Water Diesel Oil. It assures maximum economy — top performance — from every gallon of lubricant.



"70,000 Hours continuous operation . . . neutralization only .09." That's typical of the unusual performance achieved with Tycol Turbine Oil. Thanks to Tide Water's Edeleanu process, this oil has greater stability and resistance to emulsification . . . assuring more economy, steadier operation, smoother performance.



"300,000 Spindles operating for 13 years without a single lost tube" — that's a textile mill operator's way of pointing out the superior performance of Tycol Spindle Oils. For every textile application — from power plant to finishing — there's a Tycol Lubricant scientifically engineered for the job.



"Never a single bearing overheated since we changed to Tide Water Green Cast Grease," says one chief engineer. No matter how severe the service, Tide Water Green Cast Greases assure better lubrication . . . less maintenance. The reason? They contain more high-grade cylinder oil — less soap — which means better performance in every application.

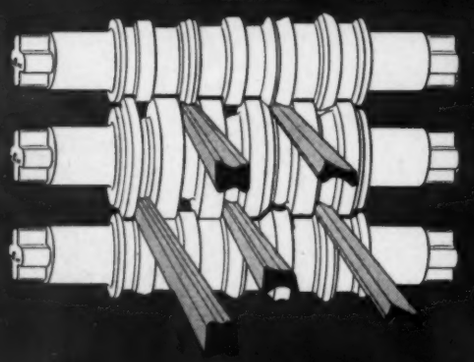
INDUSTRIAL TYCOL OILS-GREASES

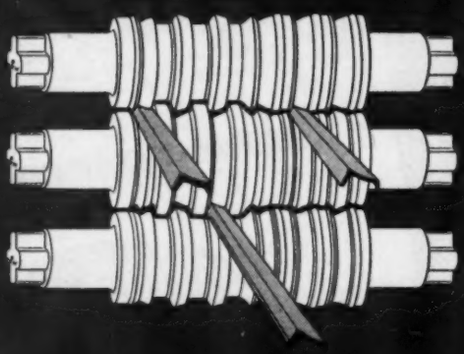
INDUSTRIAL LUBRICANTS

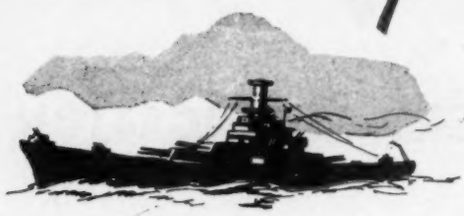
ENGINEERED FOR EVERY INDUSTRIAL USE

ROLLING TECHNIQUE ...

Bulb Angles



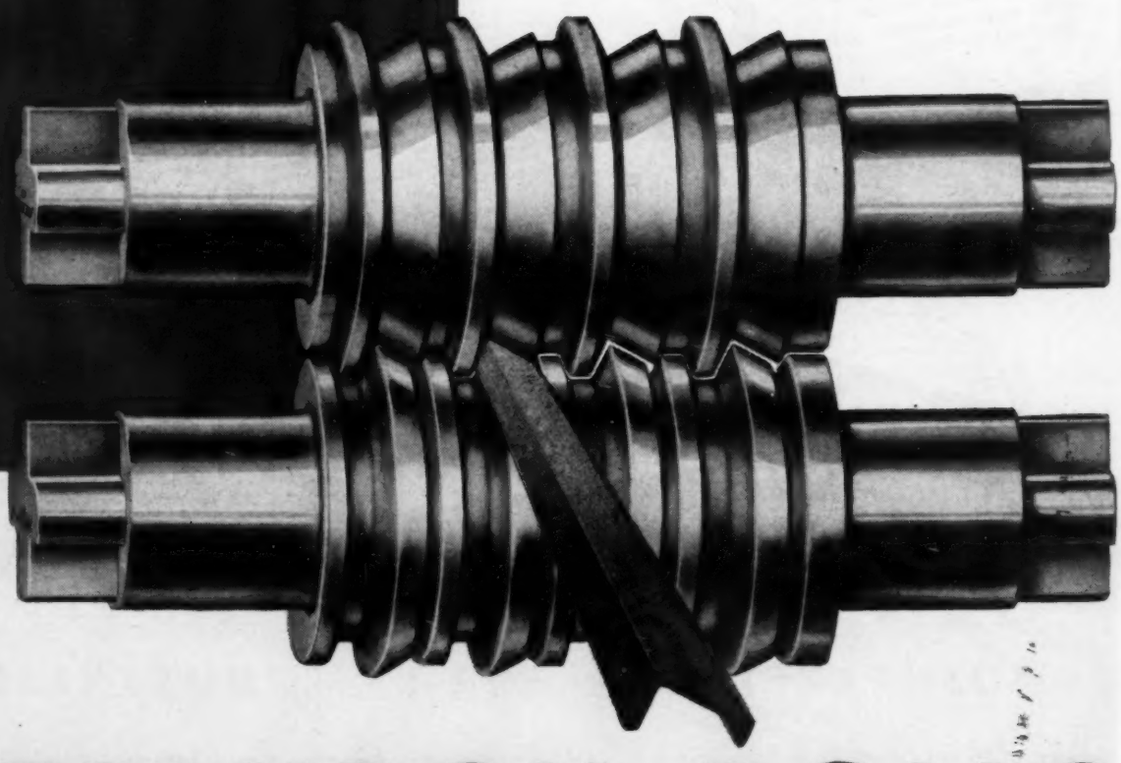




The technique of hot rolling steel or non-ferrous materials into desired shapes must conform to both cost and quality standards. Rolling with the minimum number of passes is desirable but should not be practiced at the expense of quality, finish or strength of the finished product.

For the construction of our vast fleets of naval and merchant vessels many hundred thousand linear feet of Bulb Angles are required—much of which passes through Pittsburgh Precision Rolls *at less cost per ton of steel rolled.*

PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.



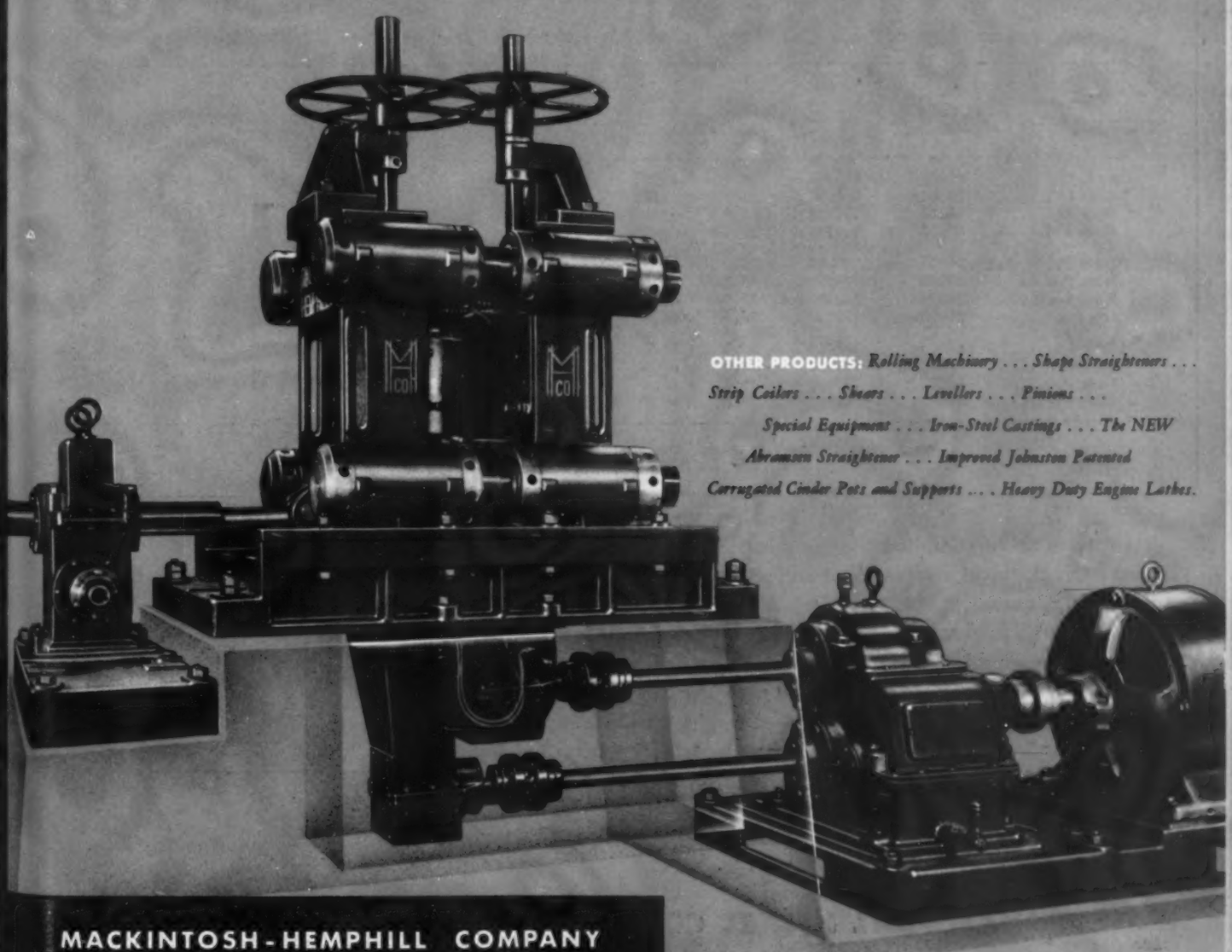
PITTSBURGH ROLLS

Here is a vertical precision mill of exceptional accuracy. It handles rounds from ⅜" to 1⅝" diameter and can be set up to edge shapes and flats. The extremely simple and rigid design of this mill and its easily accessible adjustments and locking devices have helped make it an outstanding success.

Equipment of this kind typifies Mack-Hemp's *advanced industrial thinking* backed up by their perfectly coordinated, balanced and specialized facilities in metallurgy, engineering and manufacturing.

Mack-Hemp is heavy industry's proved and logical approach to increased production, reduced operating costs, higher quality products. They may help *you* to meet tomorrow's competition.

Rolls hot rounds within cold round tolerances

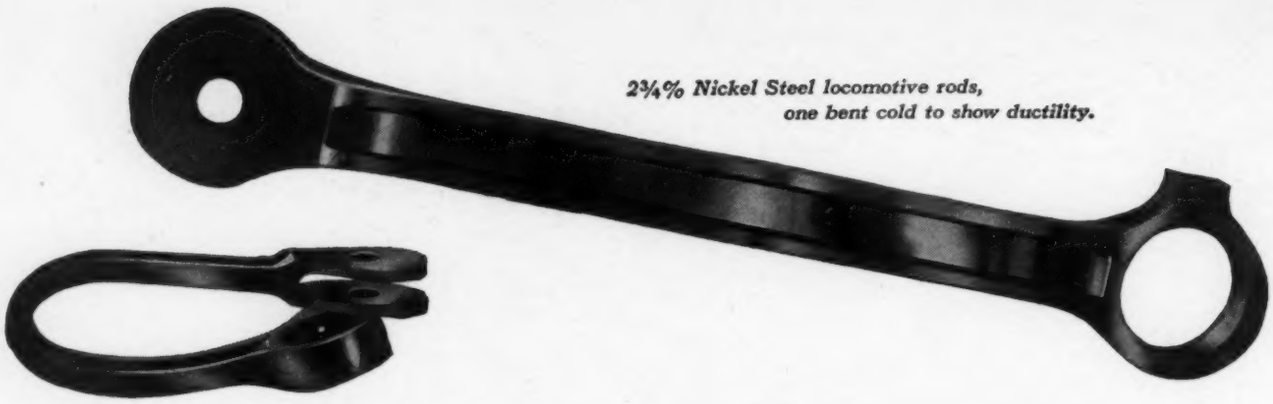


OTHER PRODUCTS: *Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramson Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.*

MACKINTOSH-HEMPHILL COMPANY

PITTSBURGH AND MIDLAND, PA.

MAKERS OF THE ROLLS WITH THE RED WABBLERS



2¾% Nickel Steel locomotive rods, one bent cold to show ductility.

QUENCHED AND TEMPERED NICKEL STEEL FORGINGS COMBINE

EXCEPTIONAL DUCTILITY WITH HIGH TENSILE STRENGTH

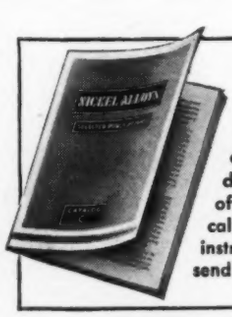
Composition and Typical Properties of Normalized Quenched and Tempered 2¾% Nickel Steel Rods

Description or Size	Melt Yield Pt. No. #s per Sq. In.	Tensile Strength #s per Sq. In.	Elong. % in 2 In.	Reduction in Area %	ANALYSIS					
					Car.	Mang.	Phos.	Sul.	Sil.	Ni
Main Rod....	92900	110000	25.0	64.4	.31	.78	.027	.026	.25	2.75
Main Rod....	86500	104500	25.5	65.6	.32	.86	.034	.032	.29	2.69
Main Rod....	86360	104400	26.0	64.8	.32	.86	.034	.032	.29	2.69
Main Rod....	87850	102350	26.0	66.2	.31	.89	.037	.025	.32	2.69
Front Rod....	86000	102250	25.0	67.3	.29	.82	.035	.027	.24	2.71
Front Rod....	83900	104250	25.0	66.1	.29	.82	.035	.027	.24	2.71
Front Rod....	86850	104250	27.0	66.1	.32	.86	.035	.025	.30	2.65
Front Rod....	89500	107050	25.5	65.6	.32	.86	.035	.025	.30	2.65
Back Rod....	89500	107650	25.0	62.7	.30	.79	.030	.025	.22	2.71
Back Rod....	87500	106450	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	87000	105600	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	88150	104850	26.0	66.8	.29	.82	.035	.027	.24	2.71

Specimens Taken from Mid-Section of Prolongations of the Forgings

The above table compiled by the American Locomotive Company shows the chemical compositions and mechanical properties of some normalized, quenched and tempered nickel steel front, main and back rods recently produced as replacement rods for locomotives being speeded up and rebalanced. These values are typical of replacement rod forgings recently tested by that company.

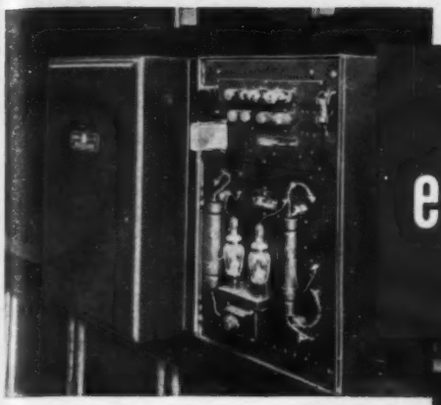
Quenched and tempered nickel steel forgings provide high tensile strength and ductility, combined with unusual toughness and high fatigue strength—qualities which tend to obviate breakage and assure long, trouble-free service when employed in heavy duty machinery and equipment.



Catalog "C" makes it easy for you to get booklets and bulletins on industrial applications of Nickel, metallurgical data and working instructions. Why not send for your copy today?

* *Nickel* *

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall Street, New York 5, N. Y.*



Two of the compact Thy-mo-trol electronic panels (one with cover removed) which rectify and control the power operating the reel motors.

electronic self-adjusting drive

...coils strip at constant tension

Thy-mo-trol d-c drive motors (400/1600 rpm) operate through speed reducers to provide the required reel speed. Motor field-control automatically reduces speed as coil diameter builds up, holding tension constant.

At Allegheny-Ludlum Steel Corp., West Leechburg, Pa., smooth, constant-tension coil winding is now possible on the delivery reels of strip-annealing furnaces. The mechanical problems of slip-clutch operation have been eliminated. Full flexibility to handle strip speeds from 3 to 12 fpm is provided. The drive adjusts itself to the speed changes required to allow for coil build-up from 16 to 40 inches in diameter.

OPERATES FROM A-C POWER

Operated from an a-c power source, 2-hp Thy-mo-trol drives on these small reels give the same stepless speed control and torque control that is obtained with larger d-c adjustable voltage systems on mill drives. The operator sets a tension-adjusting rheostat at the desired value, and this level is held throughout the wind-up of the coil.

WIDELY APPLIED

This is only one of the increasing number of Thy-mo-trol applications throughout the steel industry, where stepless speed control, constant acceleration, or constant speed under changing loads is required.

You buy Thy-mo-trol drive as a complete, co-ordinated set of equipment, including d-c motor, electronic panel, transformer, and control station. *Standard* drives can be obtained from 1/8 to 25 hp. G-E engineers will help you select and apply Thy-mo-trol drives, or explore their suitability for new types of jobs. To read the full story, ask for Bulletin GEA-4025. *General Electric Company, Schenectady 5, N. Y.*

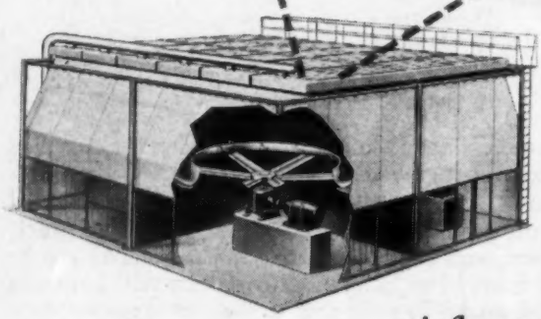
GENERAL ELECTRIC

670-176-8930

Buy all the BONDS you can—*and keep all you buy*

THY-MO-TROL DRIVE

THE FIN•FAN HEAT EXCHANGER actually solves two problems: 1. It provides an efficient cooling unit where water is scarce or expensive and where minimum temperature required is approximately dry bulb temperature. 2. Where gases, liquids or vapors at high temperatures and pressures must be cooled or condensed.



The many exclusive features of the Fin•Fan Heat Exchanger make it ideal as a steam condenser, jacket-water cooler or hot oil cooler for all services under pressures to 5000 P.S.I. and temperatures to 1500° F.

The Fin•Fan Heat Exchanger consists of finned tubes, cooled by air circulated through the unit by fans. Vertical air flow prevents recycling of hot air by prevailing winds.

Maintenance cost is negligible. Expense of cleaning, descaling and replacement of parts corroded by the use of water is eliminated.

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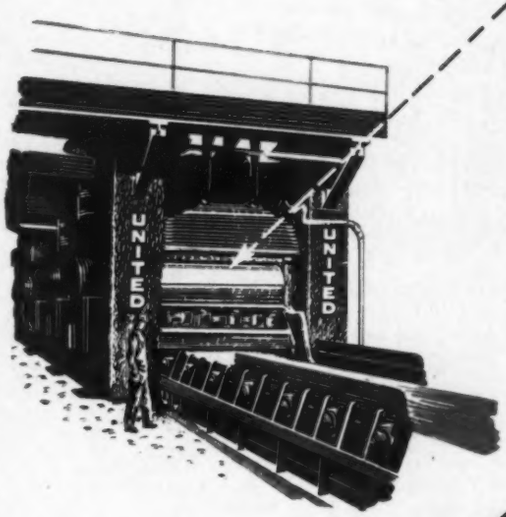
PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa

United

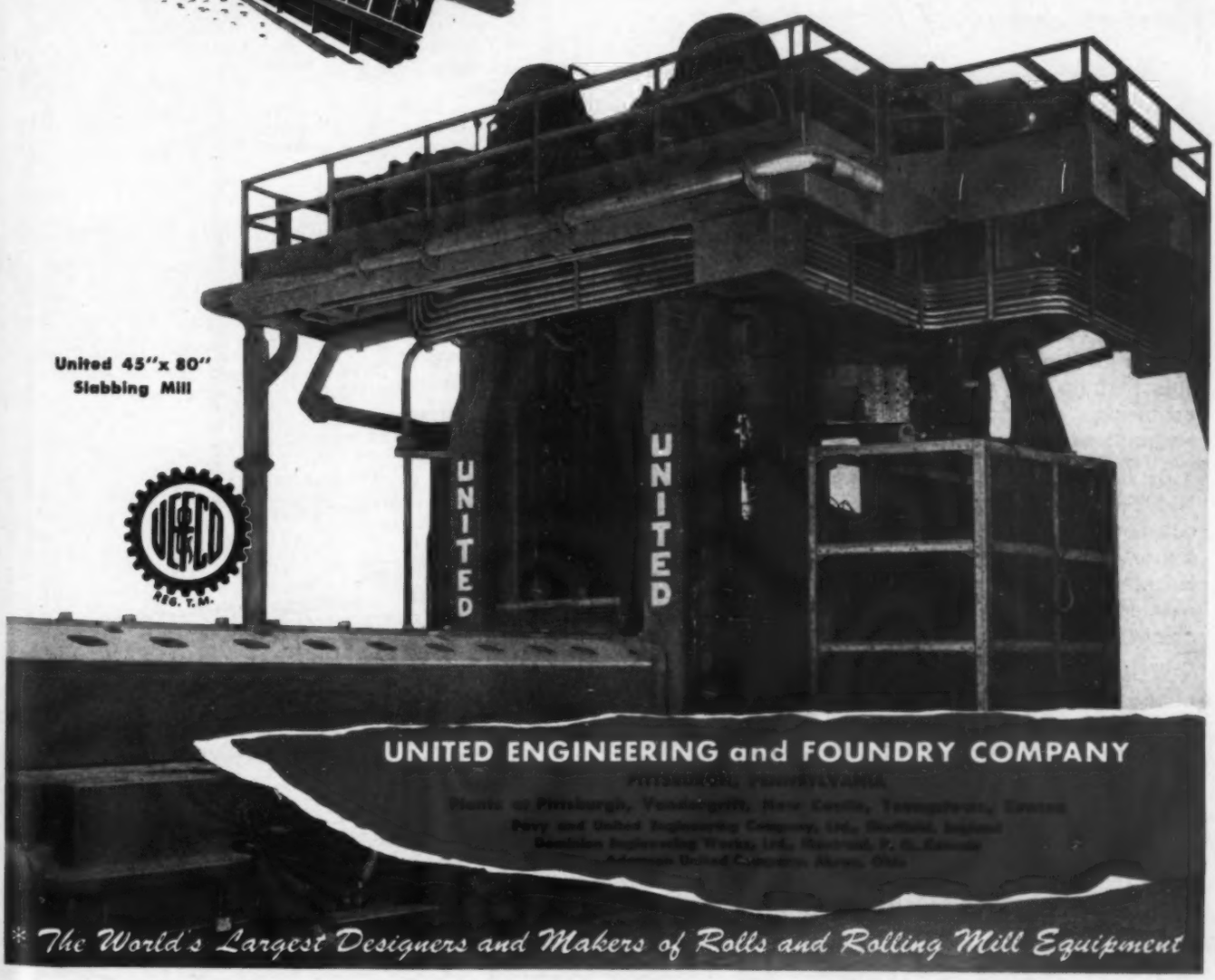
designers and builders of all types of

Rolling Mills



★ Blooming
★ Slabbing
★ Plate
★ Universal 2, 3, 4-high
★ 4-high Hot Strip
★ Bar
★ Rail and Structural
★ Merchant
★ Rod
★ Skelp
★ Pipe and Tube
★ 2 and 4-high Cold Strip
★ Sheet
★ Tin
★ Uni-Temper

In all types: Single Stand, One Way or Reversing, Tandem, Continuous, etc. For Carbon Sheet, Alloy Steels, Copper, Brass, Aluminum and other Non-Ferrous Metals.



United 45"x 80" Slabbing Mill

UEC REG. T.M.

UNITED ENGINEERING and FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Vandergrift, New Castle, Youngstown, Canton
Perry and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q., Canada
Alliance United Corporation, Alliance, Ohio

* *The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

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QUICK ANSWER CHART
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JOHNS-MANVILLE INSULATION
for every industrial temperature"

NOW, you can see at a glance the recommended material for every temperature range, from minus 400° F. to plus 2600° F.

It's all on this convenient J-M Chart (11½ x 18 inches, in color) available for your office or plant wall.

Each material in this J-M group of insulations is tailor-made to do one special job *best.* And, as part of the Johns-Manville Insulation Service, J-M specialists are available to help you with present insulation problems . . . or with those connected with future plans.

By having these insulations applied by J-M Technical Service Units or J-M's own construction forces, you will be certain of a thorough, speedy and economical installation. In this way you can be assured of obtaining the utmost in both insulating efficiency and length of service.

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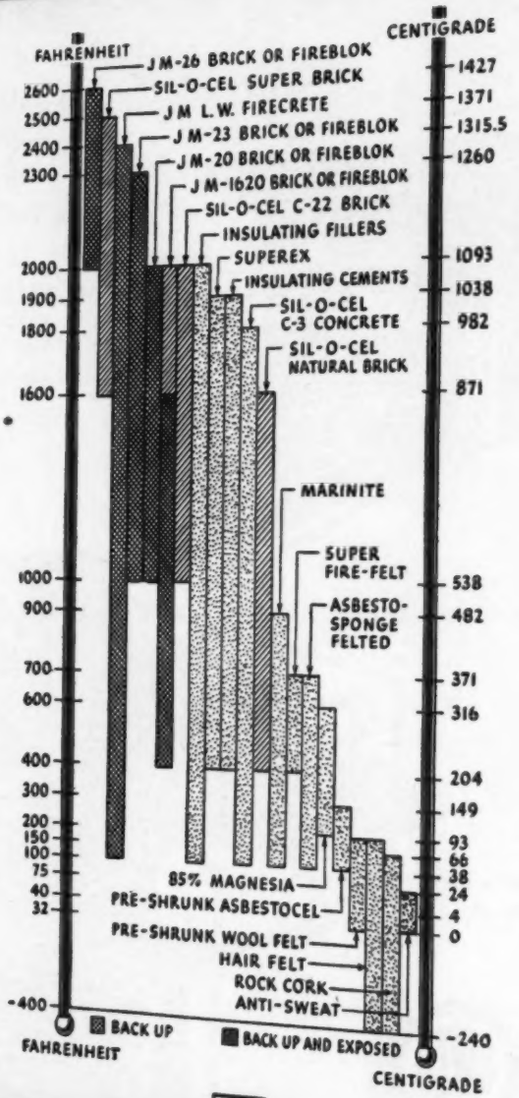

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EVERY SERVICE CONDITION

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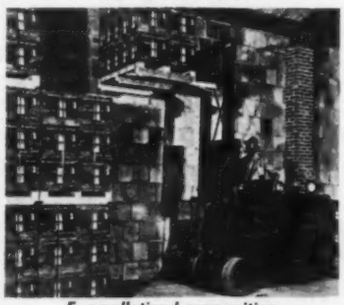
INDUSTRIAL INSULATIONS
for every temperature—for every service

Destination---
"ADVANCE BASES"

Safe and speedy handling of supplies and ammunition for the NAVY and ARMY with Battery Powered "Electric Propelled" Material Handling Equipment

Aboard ship with palletized shipments

On barges or lighters



For palletized ammunition in magazine

Pictures courtesy "The Palletizer" U. S. Navy Bureau or Ordnance

TRADE **AUTOMATIC** MARK

"AUTOMATIC" is keeping up the pace in the unrelenting production of Electric Battery Powered Industrial Trucks and "TRANSPORTER" Lift Trucks for the speedy—but safe—handling of ammunition and supplies for the Navy and Army.

In 1942 we were awarded the Navy "E" Burgee as a result of the tireless effort of "AUTOMATIC" employees in the continued production of equipment essential to the war effort.

Our organization, loyal to the core, has kept up the pace set when Uncle Sam first called for all out production.

So now, for the fourth time "AUTOMATIC" employees have won the Navy Production Award for meritorious service on the industrial field of battle for Navy-Army production.

The fourth Silver Star has been placed on the Navy "E" Burgee we so proudly fly.

We'll keep it up—that is the spirit that prevails at "AUTOMATIC." Here we are all dedicated to the task of producing more and producing on time.

In ammunition igloos

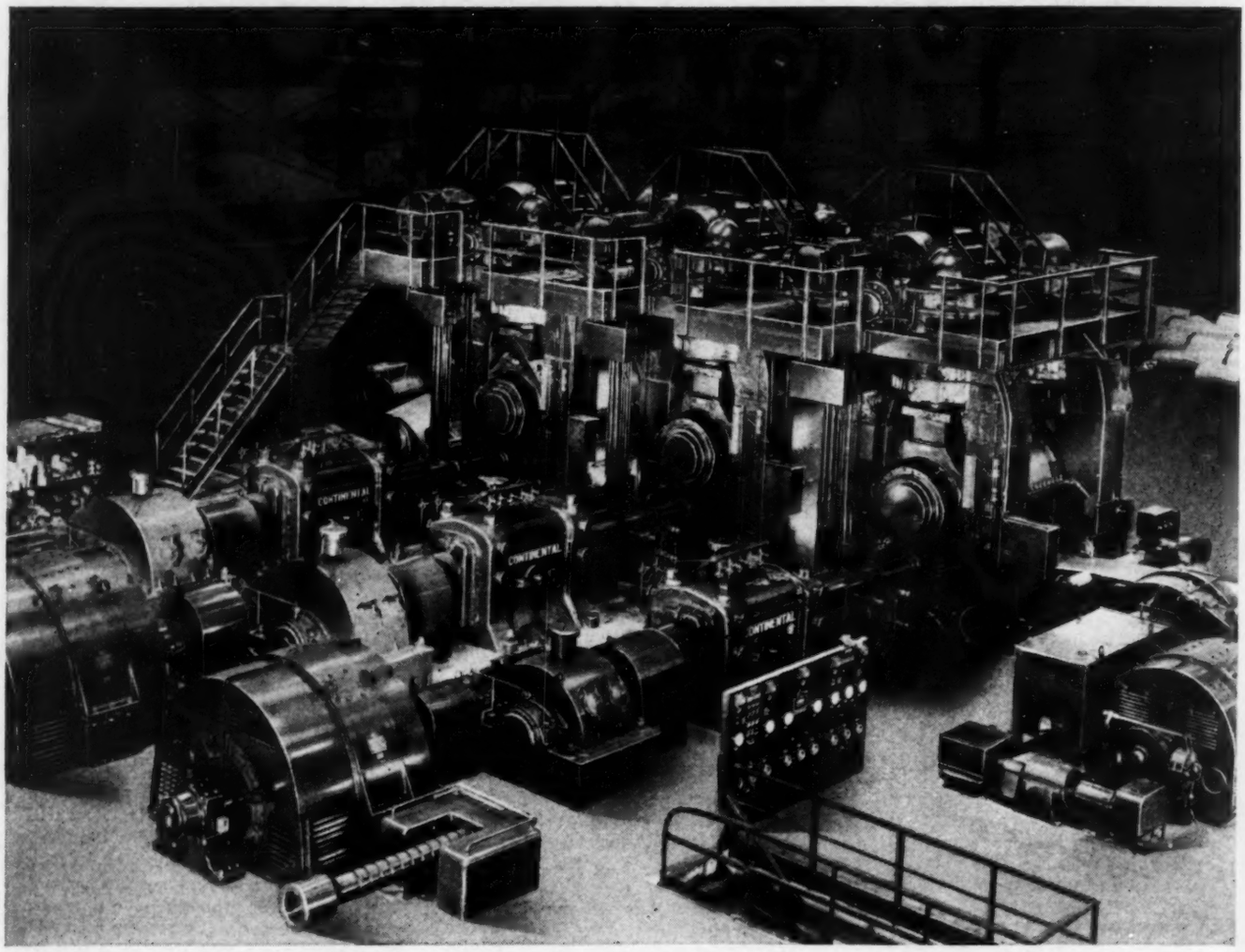
For palletized carloading

In warehouses

ELECTRIC INDUSTRIAL TRUCKS
MEMBER OF ELECTRIC INDUSTRIAL TRUCK ASSN.
208 South La Salle St., Chicago, Ill.

AUTOMATIC TRANSPORTATION CO.
47 WEST 87th STREET CHICAGO 20, ILL.
Division of the Yale & Towne Manufacturing Company

CONTINENTAL
4 HIGH COLD STRIP MILL

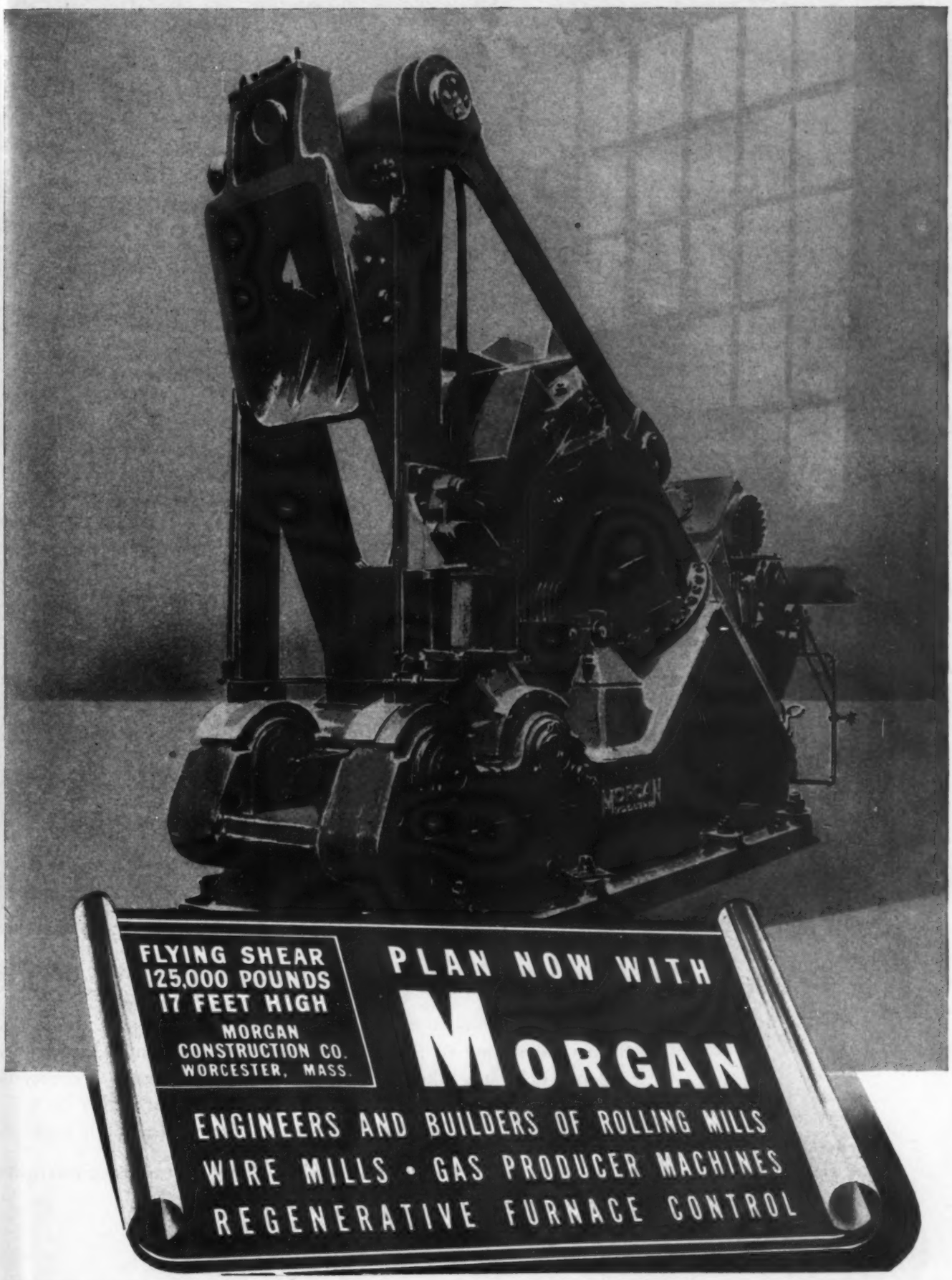


Three Stand Tandem Cold Mill designed and built by Continental. This installation is one of many types of mill units furnished by Continental to the steel industry.

Other products include: Rolls, Mill Equipment and Steel Castings.

CONTINENTAL
FOUNDRY & MACHINE COMPANY
CHICAGO • PITTSBURGH

CHICAGO WORKS East Chicago, Ind. | PITTSBURGH WORKS Coraopolis, Pa. | WHEELING WORKS Wheeling, W. Va. | WARWOOD WORKS Wheeling, W. Va.



ENGLISH REPRESENTATIVE: INTERNATIONAL CONSTRUCTION CO., 56 KINGSWAY, LONDON, W.C. 2, ENGLAND

His Precise Skill Shows Up in Your Lewis Rolls

One thousandth, plus or minus, on a big 24-inch roll may sound like "splitting hairs" but to Supt. Isaac Jones it means right or wrong. For 18 years, he has taken pride in giving watchmaker's accuracy to the finishing of Lewis Rolls—accuracy that pays dividends to mills which must roll to close tolerances while maintaining high tonnage.

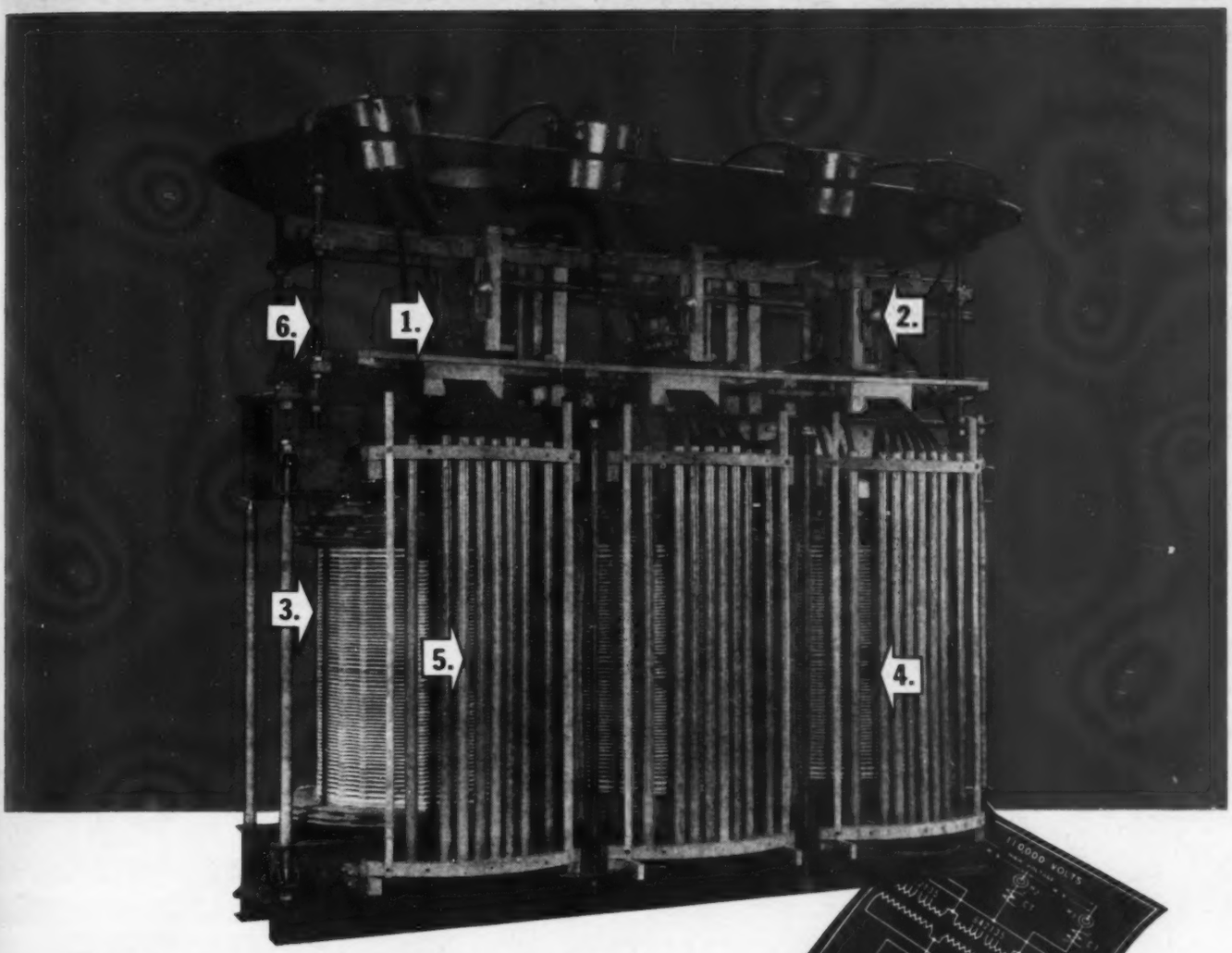
Back of "Ike" and back of every Lewis Roll are hundreds of men who know what to do and how to do it.

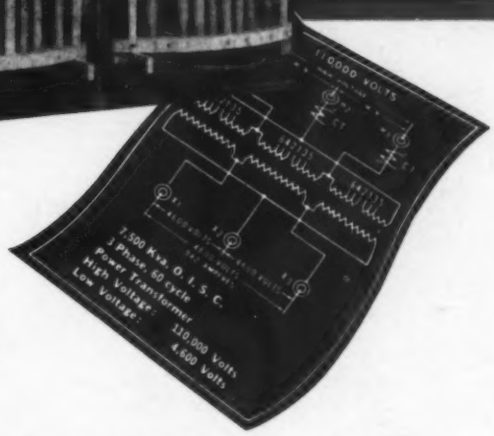
LEWIS FOUNDRY & MACHINE
Division of BLAW-KNOX Company, Pittsburgh, Pa.

ARMY E NAVY

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and
non-ferrous industries

LEWIS ROLLS





Features you look for and get in *Pennsylvania* Power Transformers!

1. Straight-line Tap Changers with Silver to Silver Contacts easily accessible for inspection and cleaning through manholes in cover.

2. The tap changers of the three phases are operated by a common shaft which issues through the side of the tank and can be operated from the floor, if desired. Static shields are provided on tap changers on all high voltage transformers.

3. Before the coils are placed on the core, they are subjected to hydraulic pressure greater than the stresses encountered in service under the most severe short-circuit conditions. This insures the ability of the transformer to withstand short-circuits with safety.

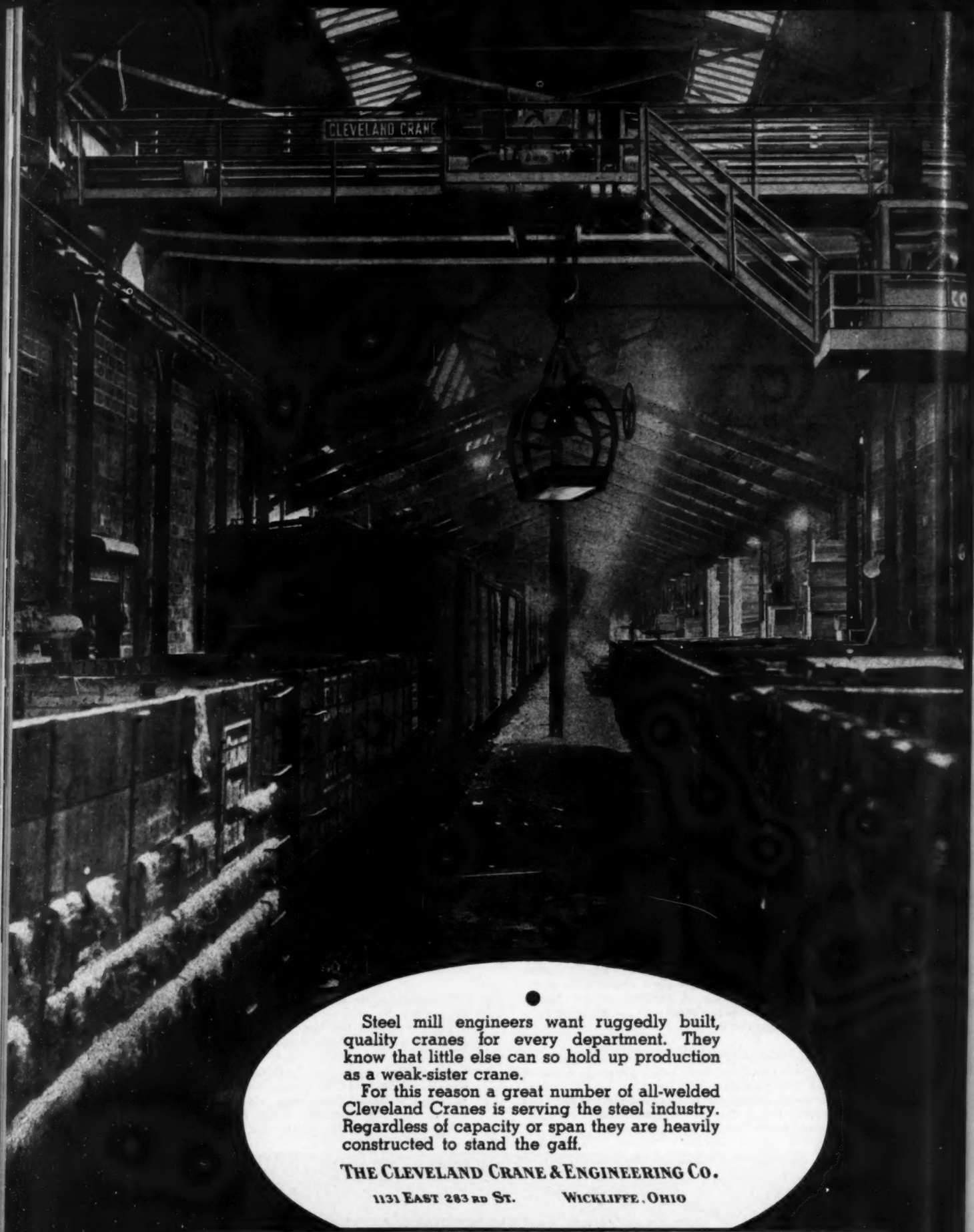
4. The regulating taps are located in such places of the winding as to cause a minimum of unbalancing. Each tap is made at an outside cross-over connection between pancakes, thus leaving the spaces between coils free for oil circulation and providing better insulation and clearances for tap leads.

5. The line and tap leads consist of heavily insulated cables supported by stiff insulating tubes, thus providing a rigid support for the leads and preventing any possible distortion and damage during short-circuits.

6. Core, coils, cover and bushings form an assembly which can be lifted as a unit, and which permits untanking without disturbing electrical connections inside the transformer. Four heavy rods provide solid support for the cover and bushings.

Pennsylvania TRANSFORMER COMPANY
808 RIDGE AVENUE, N. S., PITTSBURGH 12, PA.

Pennsylvania TRANSFORMERS



Steel mill engineers want ruggedly built, quality cranes for every department. They know that little else can so hold up production as a weak-sister crane.

For this reason a great number of all-welded Cleveland Cranes is serving the steel industry. Regardless of capacity or span they are heavily constructed to stand the gaff.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

ACCORDING to the American Iron and Steel Institute, our annual steelmaking capacity at the start of the year was 95,505,280 tons, an increase of 1,500,000 tons during 1944, and 14,000,000 tons since mid-1940 when the defense program was started. This total is made up of 84,171,590 tons of open hearth, 5,874,000 tons of bessemer, 5,455,890 tons of electric furnace, and 3800 tons of crucible capacity. On the other hand, blast furnace capacity shows a decrease caused by abandoning or dismantling old furnaces, and now totals 67,313,890 tons per year. Coke capacity is now 61,919,840 tons per year, new by-product ovens having accounted for an increase of 469,860 tons during 1944.

▲

MAYBE we're peculiar, but we can't worry half as much about what form of government will exist in liberated countries as we can about our own postwar government. Will we have truly representative government by Constitution or will we have bureaucracy with "planned economy?"

▲

ONE of our agents reports another sign, this one at a U.S.O. entrance: "Clean and decent dancing every night except Sunday."

▲

IT is often stated that a little knowledge is a dangerous thing. So, apparently, is a little power. The Aluminum Company of America recently experienced a strike of 300 workers because the company asked for draft deferment on 5 foremen, and not on 3 other foremen and 21 production workers. The business agent of the union said the 5 foremen could readily be replaced.

▲

AND then there's the strike which shut down Jones and Laughlin's Pittsburgh plant. Maintenance workers there objected to the company's giving an outside construction firm a contract to build new shell production facilities. Twelve years ago there was much clamor about sharing the work.

WE believe it was Columbus who proved that the world was not flat, but then he never had the opportunity of adding up our present national debts.

▲

STEEL industry payrolls in 1944 totaled $1,745,019,700, almost $96,000,000 above 1943. An average of $1.219 per hour ($56.93 per week was paid to 571,200 persons, as compared with $1.135 per hour ($48.81 per week) to 626,000 persons in 1943.

▲

ANALYSIS of a 15 minute radio news analysis: 5 minutes of stuff from today's newspapers, 5 minutes of predictions for tomorrow, and 5 minutes explaining why yesterday's predictions didn't happen today.

▲

STOCKPILING of materials for which we depend more or less on import is strongly urged by Army-Navy officials. Items particularly stressed are bauxite, chromite, cobalt, copper, cordage fibers, lead, manganese ore, nickel, palm oil, pepper, platinum, quinine, tin, tungsten, vanadium and zinc. Also suggested in other quarters is the accumulation of a large stock of iron ore from Brazil, and the import of large quantities of petroleum from the Middle East to be put into the ground for future use.

▲

PERHAPS you can drink as well sitting down as you can standing up, but can you stand up as well after you have been drinking sitting down as you can sit down after you have been drinking standing up?

▲

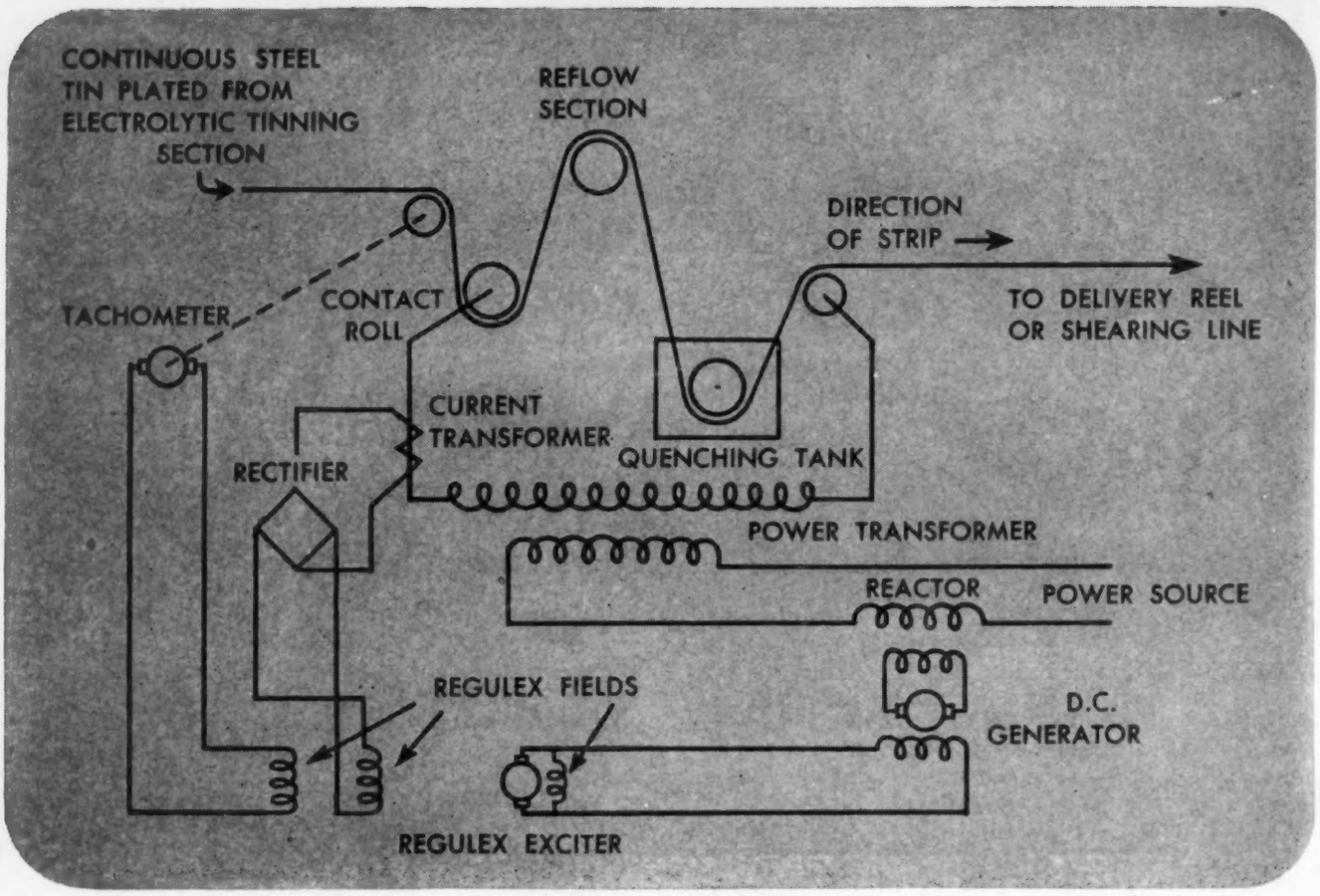
HALF of the boilers installed in power plants and large heating plants do not burn any type of coal satisfactorily and with good efficiency, according to J. E. Tobey in a talk before the American Society of Mechanical Engineers in New York. Another 40 per cent burn only a very restricted range of coals with varying degrees of satisfaction and efficiency; only 10 per cent function with high flexibility and efficiency.

▲

SOME surplus war property disposal methods were reviewed by Pathfinder recently. One example: A redistribution warehouse was authorized to sell 33,000 ft of 24 in. cast iron pipe which had cost $4.90 per foct. A deal was made to sell the lot for $4.53½ per foot and a certified check for 10 per cent was in hand as earnest money. Washington stepped in, cancelled the sale and turned the pipe over to RFC. Later RFC sold the lot to a junk man for $2.15 per foot.

▲

BUREAU of Mines figures show a total of 14,615 by-product coke ovens, totaling 73,708,000 tons annual capacity, in 91 plants and 17,500 beehive ovens, totaling 11,000,000 tons annual capacity, in 105 plants at the end of 1944. These figures include city gas plants as well as all industrial plants, and are therefore higher than the A. I. S. I. figure given above. The same report gives total coke production of 66,627,381 tons from by-product ovens and 6,990,308 tons from beehive ovens.



New Way to Get Accurate Mill Control

. . . REGULEX EXCITER NOW SPEEDS REFLOWING OF TIN PLATE

BEST KNOWN as a fast-acting arc furnace control, the Regulex*exciter is finding other important jobs to do in steel mills. Controlling the current used in reflowing electrolytic tin plate, for a mirror-like finish, is one of the newest of these.

Here, the Regulex machine excites a d-c generator, which energizes a saturating reactor. The reactor, in turn, controls the voltage input to the transformer supplying power to reflow the electrolytically-deposited tin.

Controlled by Regulex, voltage changes are lightning-quick . . . matching closely the speed changes of the line. Finished tin plate is produced faster and with less scrap!

Maybe *you* have a mill problem that can be solved more efficiently with accurate Regulex control . . . which maintains constant such quantities as current, voltage, torque, tension, and speed. See our nearby district office, or write ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN

*Reg. T.M

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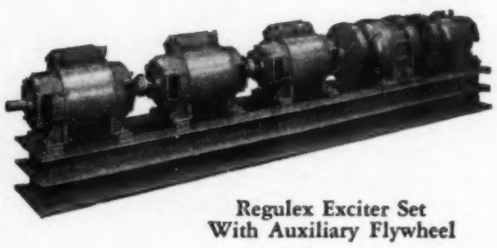

Regulex Exciter Set
With Auxiliary Flywheel

Only Regulex Control Gives Arc Furnace Operators These Important Advantages:

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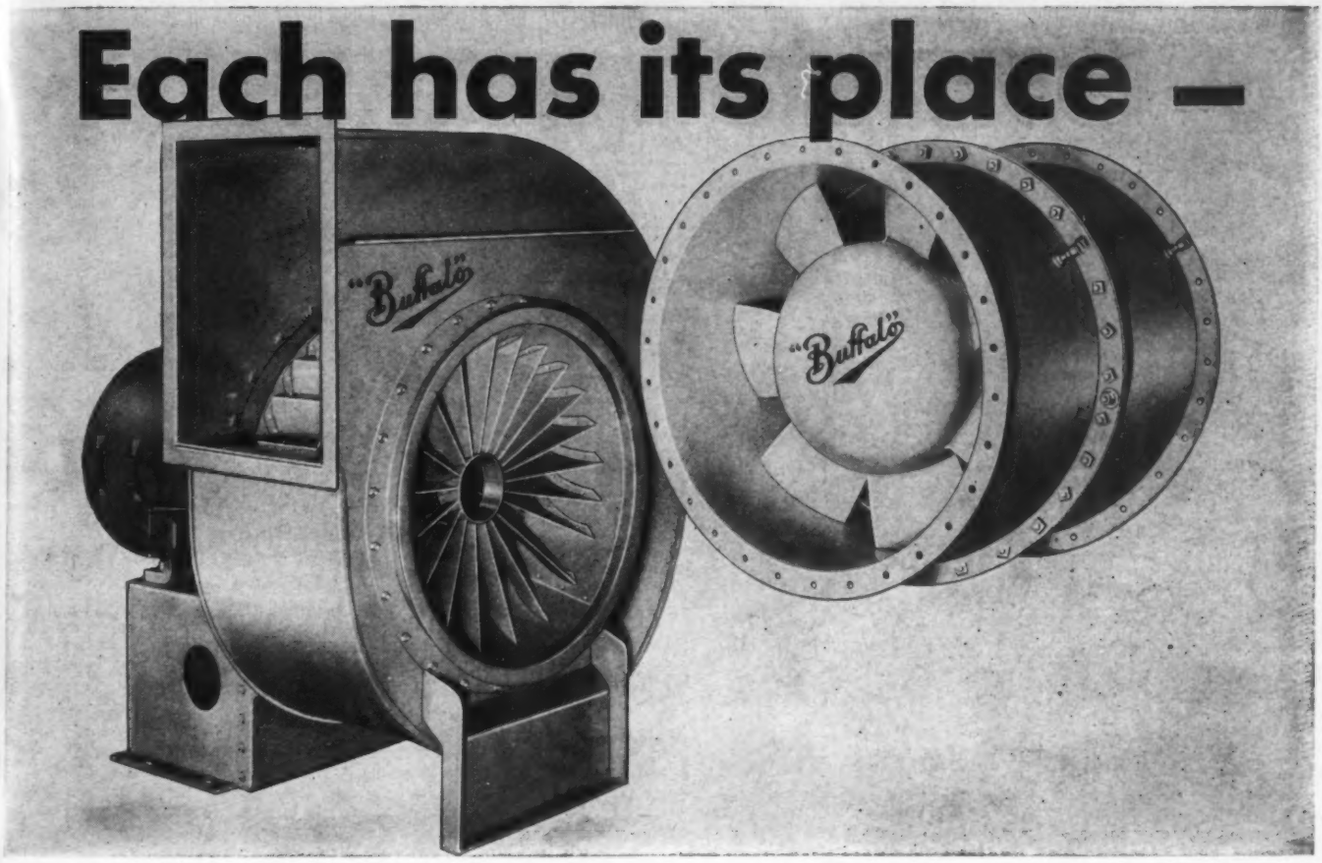
- Heavy starting surges caused by throwing the 250 volt direct current motor across-the-line are eliminated by variable voltage control.
- Absence of contacts and motor line contactors means that maintenance is slashed!
- Flywheel can be provided for automatically raising the electrodes when power supply fails.
- Auxiliary generator makes Regulex control self-sustaining and independent of a direct current shop source, if desired.

A 1834

Each has its place —



In this age of industrial, military and professional specialization, every piece of equipment should "stand on its own legs." In the fan industry the relatively new axial flow fan meets many special installation requirements. It is ideal for the low pressure service encountered in air conditioning, ventilating and some industrial work.

On the other hand, the old, highly-developed centrifugal fan is usually better where the duct system requires elbows or bad connections near the fan inlet or outlet; or where pressures above 5″ or 6″ static are encountered, or where heavily dust-laden air is handled.

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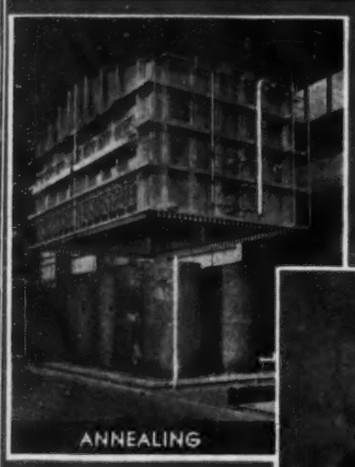
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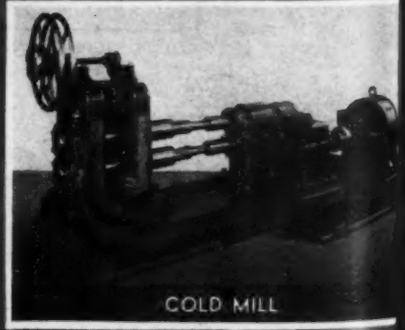
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Iron and Steel ENGINEER

MARCH 1945 VOL. XXII NO. III

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Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS

Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879
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Single Copy Foreign Prepaid $2.00 Single Copy $1.50
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Subscription price in Canada (U. S. funds) ..... $ 8.25 per year
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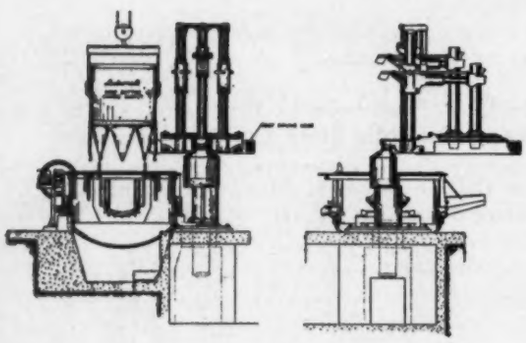

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THE *Universal Slabbing Mill* AT HOMESTEAD

. . . . part of the new facilities erected at Homestead by Carnegie-Illinois Steel Corporation for Defense Plant Corporation, this rolling mill has several innovations in design which are well worth considering . . . .

by **A. G. ERICSON,** CHIEF ENGINEER
CARNEGIE-ILLINOIS STEEL CORPORATION
HOMESTEAD, PENNSYLVANIA

▲ PROVIDING a large additional source of steel for the war effort, the recently finished units at Homestead include one 45 in. x 80 in. universal slabbing mill. It is one of the most modern mills of its kind in America.

Ingots from the eleven 225-ton open hearth furnace plant adjacent to the mill are brought to the stripper building, 246 ft long, which is serviced by four standard gauge railroad tracks and two 200-ton stripper cranes capable of stripping big-end-up or big-end-down, plain or hot-top ingots.

After ingots have been stripped, they are conveyed on their cars over standard gauge tracks to the pit furnace building. This building, about 600 ft long and with a crane bay of 100 ft span, and leanto of 16 ft span, is in a direct line and part of the 45 in. mill building proper. The ingot heating pit furnaces consist of ten rows of two pit furnaces per row, and are bottom fired, non-reversing, recuperative pits. For every row of pits there is one brick stack, 5 ft inside diameter by 100 ft high.

The 20 pit furnaces, each 15 ft x 16 ft x 13 ft deep, comprise the soaking pit installation. The building is well lighted and ventilated, with complete provisions for safety of personnel and protection of equipment.

The furnaces are of individual construction with space between them to permit ventilation. They are located along the lean-to side of the building. The two ingot car tracks and the ingot transfer car track are on the opposite side from the lean-to. The mill is on the east end and cover repair and repair material storage on the west end of the pit furnaces. At this end, space is available for additional heating units.

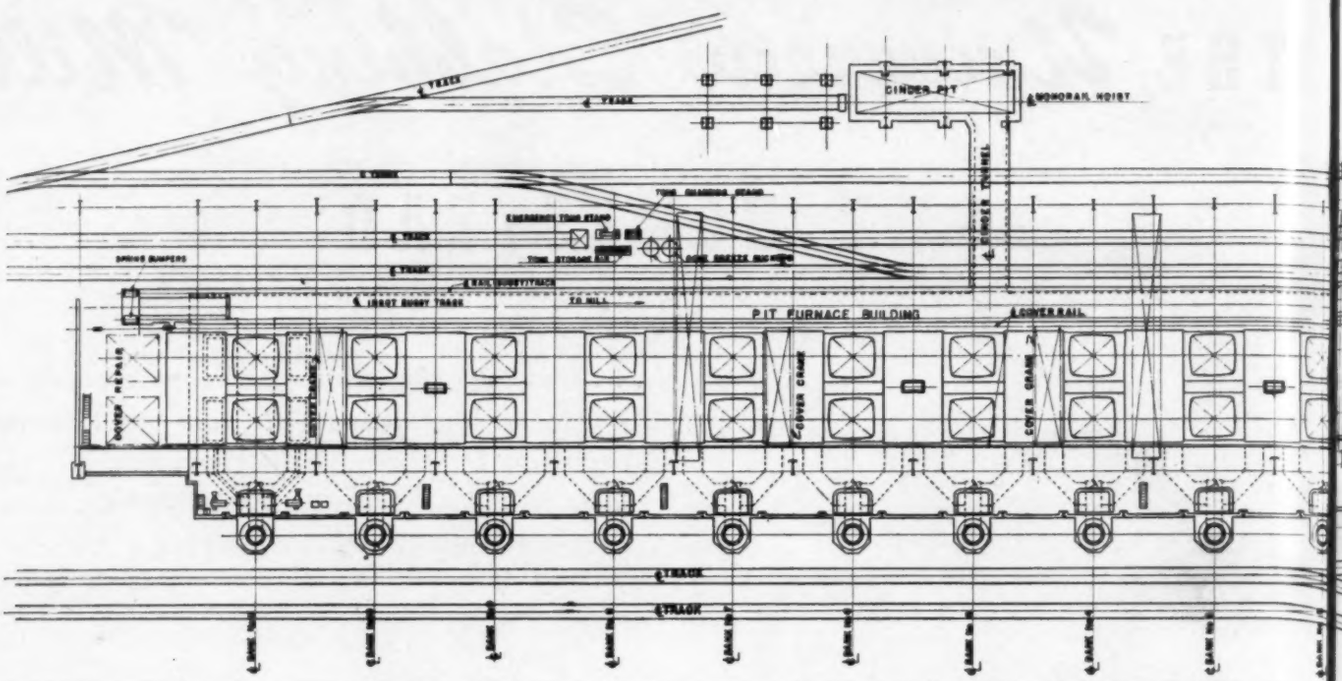
The plant is equipped with three 25-ton charging cranes, and tong cooling tanks are conveniently located on the main deck level to save crane time.

The pit covers are handled by three double span, cab operated cover carriages. Cover and carriage are separated, thus effecting a saving in capital investment. Each carriage is a double girder bridge spanning the double row of furnaces, and is equipped with two hoisting mechanisms and one traversing mechanism. The cab on the lean-to end contains all controls, including foot brake and warning gong. To raise the covers, jaws on the hoisting mechanisms are brought into engagement with four lugs on the covers. Precise interlocks and controls assure raising or lowering of the cover only when the carriage is centrally located over the pit furnace.

To facilitate cover inspection, removable sections are located in the main charging deck and the controls

Presented before A. I. S. E. Pittsburgh District Section Meeting, November 13, 1944.

Figure 1 — Layout of the 45 in. x 80 in. universal slabbing mill at Homestead.



permit the use of this facility for periodic inspection of the underside of the cover. Cover replacement is also simplified and two spare covers are conveniently stored at the repair pit.

Coke braize for making pit bottoms is dumped from hopper cars into a receiving pit located alongside the mill building at the mill end. This pit is under a covered crane runway and the coke braize is lifted by a grab bucket and loaded into drop bottom buckets placed on an electrically operated transfer car to bring them into the mill building for transfer by the pit cranes to the pits.

For bottom maintenance, coke braize placement is easily accomplished by means of these circular type buckets fitted with hopper bottom and dump gate handled by the charging crane. Coke dressing involves merely scraping the bottom cinder across the hearth to each of four cleanout holes with a spade type tool manipulated by the charging crane. The cleanout hole gates are operated from the first floor for safety.

Cinder removal is accomplished from the cellar floor by placing buckets under the cleanout doors. These buckets are moved by a lift type battery-operated car through a header tunnel running the entire length of the building to a pit outside, where they are lifted by a monorail hoist and dumped into cars.

Representative ingot sizes and distribution of ingots per pit are usually:

Six, 29 in. x 66 in.
Four, 34 in. x 66 in.
Six, 27 in. x 57 in.
Four, 32 in. x 60 in.
Six, 26 in. x 53 in.
Four, 28 in. x 46 in.

The most common size charged is 29 in. x 66 in. x 96 in. long. This ingot weighs 40,425 lb. The common size of big-end-up ingots charged is 34 in. x 66 in. With the hot-top, this ingot weighs 55,000 lb and four are charged per pit. Due to the rounded ingot bottom, it is necessary to lean this ingot in the corners of the pit. Stainless steel ingots are also heated in these pits, the sizes being 28 in. x 60 in. (37,000 lb) and 27 in. x 46 in. (26,000 lb).

When ingots are charged into the pits, the temperature control is set and the gas comes on automatic firing at full flow until such time as the temperature reaches the predetermined level. The gas then automatically starts to cut back as the heat is absorbed by the ingot. After soaking at the predetermined temperature, the steel is ready to roll.

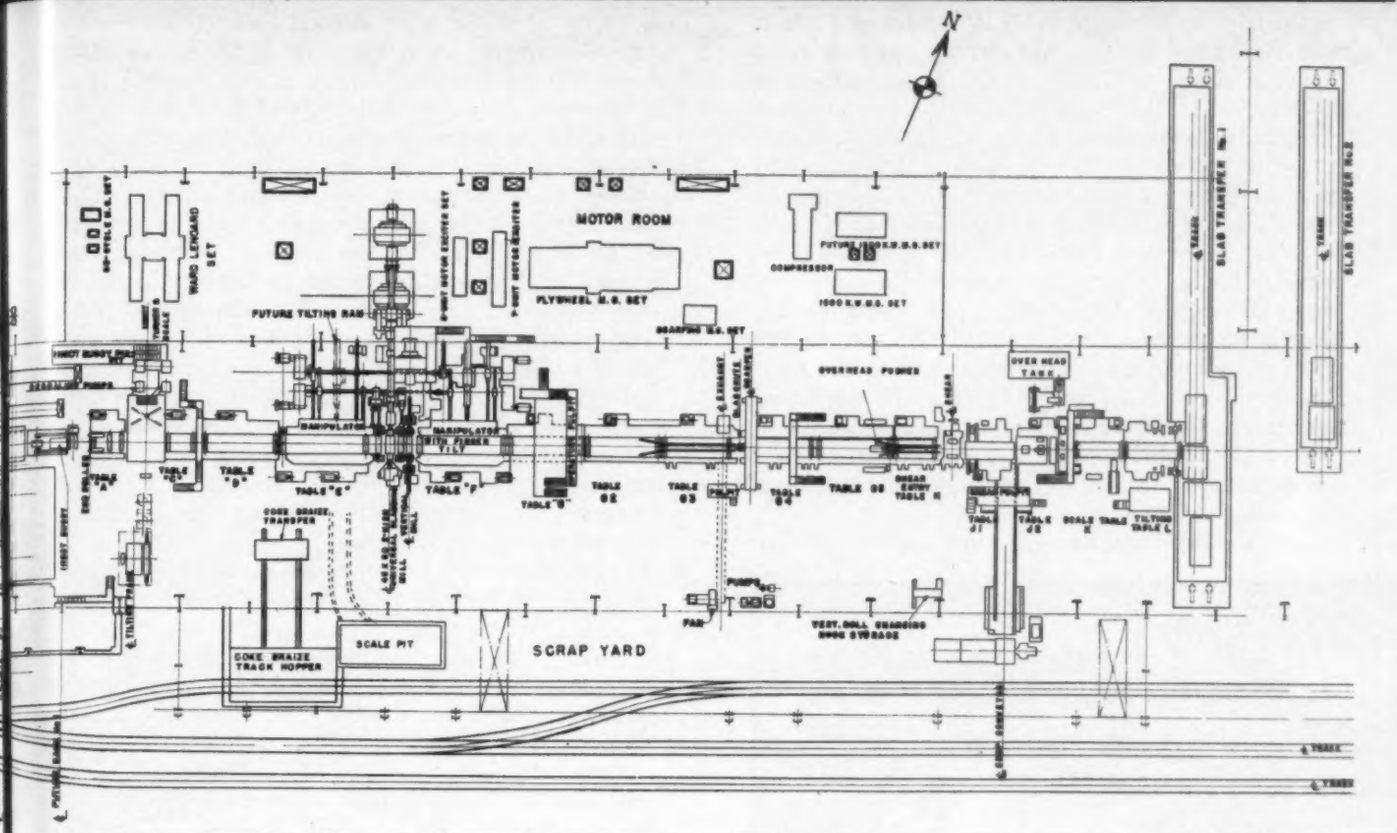
SOAKING PIT CONTROLS

The pits are equipped for full automatic operation with the following controls being used:

Gas pressure control — Actuated by a sensitive diaphragm, it controls the position of a butterfly valve in the main gas header and maintains a uniform gas pressure in the coke oven gas headers to the pits. Manual setting is also provided.

Btu control — If the fuel varies in heat value, a density control regulator positions the fuel-air ratio regulator to correct for these fluctuations.

Temperature control — In the exhaust port side walls and about 1½ ft from the top of the pit furnace, thermocouples are located for controlling and preventing overheating of any zone ahead of the control temperature point. A temperature controller begins to reduce the gas flow in regular increments as control point is approached.



Full-air ratio control — This is a regulator equipped with two sensitive diaphragms suspended on an adjustable fulcrum, which are subjected to the differential pressure created by orifice plates located in the air and gas lines.

Furnace pressure control (including recorder) maintains very nearly constant the pressure in the pit by automatic regulation of a damper in the waste gas flue. This is similar to the gas pressure control.

Automatic shutoff of gas to the pit is effected when the cover is raised and subsequent turn-on when cover is replaced. This control operates with sufficient rapidity to give the crane operator immediate visibility in the pit upon raising the cover.

Emergency gas shutoff to give positive gas shutoff in case of power failure to the fan motor is also provided.

An oil pump supplies fluid pressure for operating the various control valves. In the event that the automatic controls fail to operate properly, all controls are provided with means for manual operation. A recording and integrating gas flow meter is also included, as well as gas temperature and pressure recorders.

While a complete performance review must await a longer period of normal operation, there is every indication that these pits will heat steel in a satisfactory manner. They are giving satisfactory service and meeting all requirements to date.

ELECTRICAL EQUIPMENT

Before describing the general mill layout and the mechanical equipment, it may be appropriate to first briefly review the electrical equipment. The 45 in. slabbing mill main drives and auxiliary drives are powered with 105 motors equivalent to 21,675 hp; three motors equivalent to 13,000 hp are on the main drive, 16 equivalent to 2,010 hp are on adjustable voltage d-c auxiliary drives, 44 equivalent to 2,475 hp are straight 250 volt d-c units with magnetic control on auxiliary drives, 42 equivalent to 4,190 hp are 440 volt a-c auxiliary drives for pumps, air compressors, fans, etc.

The main drive motors are two 5,000 hp for the horizontal rolls and one 3,000 hp for the vertical rolls. Power for the main drive is supplied by three 3500 kw, 700 volt generators of a fly-wheel motor generator set driven by a 7500 hp, 6600 volt, 25 cycle wound rotor induction motor. Two exciter motor generator sets furnish power for control.

Auxiliary drives on adjustable voltage control are front tables, back tables, entry and delivery feed rolls, manipulator side guards, screwdowns and ingot buggy. Power for these auxiliaries is supplied from two 7-unit 500 volt motor generator sets driven by 1250 hp, 6600 volt, 25 cycle synchronous motors.

The d-c auxiliary drives under straight magnetic controls are supplied by one 1500 kw motor generator set. No spare was installed, as a tie line to the 160 in. plate mill nearby gives stand-by insurance.

The a-c auxiliary drives are supplied from three 1500 kva, 6600/440 volt, 25 cycle, single phase transformers connected delta-delta.

The paper on electrical equipment for the Edgar Thomson slabbing mill by R. H. Wright and B. J. Auburn (A. I. S. E. Yearbook 1940, p. 277) covers the main items of drive and auxiliaries for this mill. Changes or additions which were included in this mill are as follows:

1. Ward-Leonard control was installed on the ingot

buggy drive with two thoughts in mind: reduction in maintenance of a large number of collector rails, supports, shoes, etc., and smooth acceleration and deceleration of the massive ingot buggy. The collector rails were reduced to six for the entire length of the ingot buggy runway, with additional short rails installed at the discharge end for the electrically driven tilt and roll-off drives. The motor driven roll-off drive guarantees minimum loss of time in discharging the ingot to the receiving table.

2. Motor driven rheostats were supplied for adjusting the relative speeds of the two 5,000 hp motors and for adjusting the speed relations between the main and edger motors. These rheostats are controlled from the pulpit meter cabinet. Each rheostat is provided with a position indicator, so that the operator can adjust mill with a minimum loss of time, especially after a roll change.
3. Due to the desire to have an edge scarfer installed between the mill and the shear, six electrically driven tables required speed ranges from 100 fpm to 400 fpm. When the scarfer is not in use, the 400 fpm table speed is used continually with three tables controlled by operators in main pulpit and three controlled by operator in shear pulpit. The scarfer operator has permissive control over all six tables and can select the desired number to be controlled ahead of and back of the scarfing machine. The scarfer table speeds are varied to suit the depth of cut, the speed ranging from 100 fpm to 200 fpm. The control for this operation is obtained by the use of a bucking generator of 300 kw capacity with a voltage range of 180 volts. The shop power of 250 volts is bucked down to the desired voltage to obtain a lower speed. The scarfer heads are motor driven and the control of the tables is interlocked in such a manner as to allow preheat time of scarfer tips before tables can move.
4. The hydraulic shear requires a considerable amount of power in a short time in order to make shear operation fast enough for continuous operation of the mill. The shear is supplied with oil under pressure from three pumps. Each pump is equipped with a 400 hp, 3 phase, 1750 rpm, 25 cycle, 440 volt a-c wound rotor induction motor. The secondary control for shear pump motors is mill type magnetic with a notch-back feature including a heavy resistor for changing the rotor circuit inserting more resistance when the speed drops due to additional load, thus supplying additional torque to the motor. When not shearing, the pumps (of a positive displacement type) are unloaded by recirculating the oil. An electric device serving as unloader and loader, operated from the shear pulpit, and timed by direct connection to the pump drive, allow the operation only on the intake stroke of the cylinder. This timing device operates valves which direct the flow of oil.
5. Main and auxiliary controls are all housed in the motor room with the exception of a few a-c machine tool starters used for pumps serving as auxiliaries to the mill. Since most control trouble starts from dirt on relays and contactors, the clean dust-free air in the motor room should reflect in a lower maintenance cost as well as fewer delays to the mill.

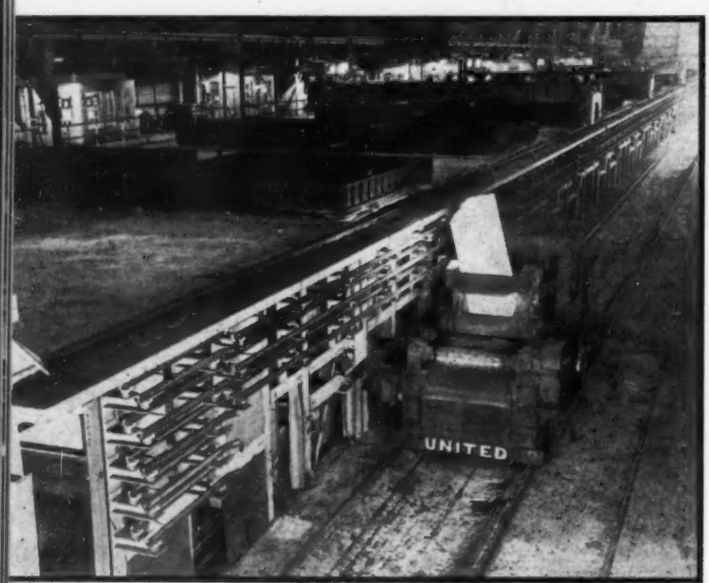


Figure 2 — Operating under adjustable-voltage control, the ingot buggy completes its longest run of 450 ft in about 50 sec.

▲

Figure 3 — The mill approach table contains a device for weighing the ingot and for turning it end-about.

In designing this mill, it was decided that, in addition to rolling ordinary low carbon steel slabs, all the grades of alloy and stainless steel manufactured by the corporation should also be rolled. The finished slabs will range in thickness from 2½ in. to 20 in. and from 20 in. to 62 in. in width, rolled from ingots ranging from 14,000 lb to as high as 70,000 lb.

With this as a background for mill rolling requirements, the next thing of interest is the arrangement of the equipment and its construction. This is shown in Figure 1 and consists of the following equipment: ingot buggy, ingot receiving table, ingot turner and scale located in mill approach table, front and back mill tables with manipulators, universal roll stand, mill runout table, scarfer, mill operators' pulpit, shear approach table, slab shear crop pusher and gauge, crop conveyor, shear pull-back table, shear runout table, slab scale, tilting table and piler cars.

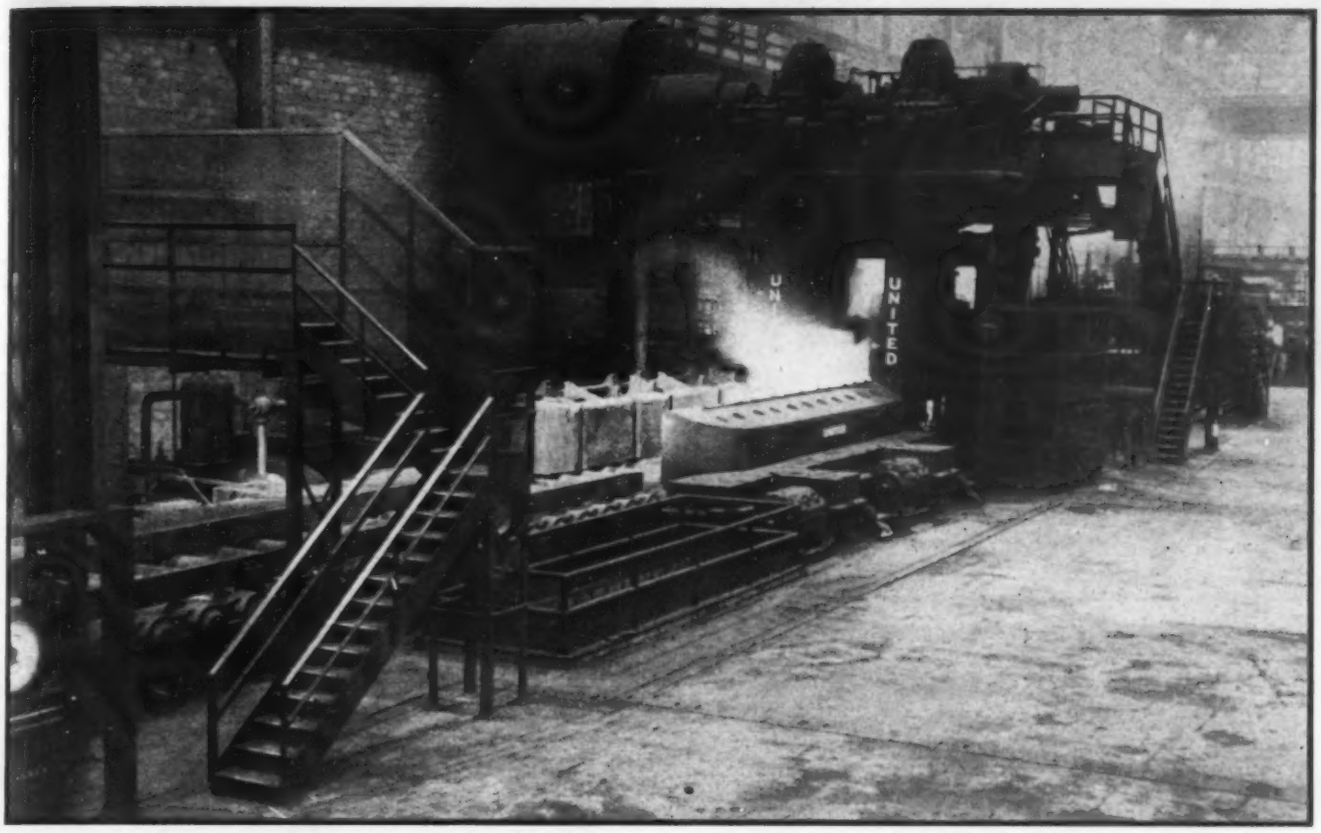


Figure 4 — The mill stand contains both horizontal and vertical rolls. Edge rolling may also be done between the horizontal rolls.

INGOT BUGGY

The ingot buggy has a maximum travel of 450 feet from the farthest pit to the ingot receiving table. The time required for this run is about 50 seconds, and the car attains a maximum speed of about 700 fpm. The ingot car speed has proven entirely adequate to keep up with the mill — in fact, most of the time it is ahead of the mill. The track gauge for the ingot buggy is 9 ft 10 in. and the track rails (175 per yard) are welded together to make a joint-free track which is most essential in maintaining smooth operation and perfect electrical contacts.

At the far end of the ingot buggy track is located a repair pit, equipped with platform and repair buggy track, with lowering jacks for easy removal of the driving mechanism located on the underside of the ingot buggy.

The traverse drive for the ingot buggy is powered by two 100 hp motors. This car is equipped with a tilting pot large enough to handle a 70,000 lb ingot, with the tilting drive mounted on the car. This pot tilts the ingot onto two driven table rollers mounted on the buggy. Mounting of table rollers on the buggy has the advantage that less accurate spotting of the car is required with respect to the ingot receiving table.

TABLES

The tables on this mill are line shaft driven and are of extremely heavy construction to withstand the shock loads encountered in a mill of this type. Roller bearings have been used throughout — on rollers, line shafts, and drives. All tables are heavily motored for rapid acceleration.

WEIGHING AND TURNING DEVICE

In the mill approach table, a device has been included for weighing and turning the ingot. The weighing of ingots at this point is fairly common practice, but few mills are equipped with a turning device, so some explanation is in order at this point. The ingot coming from the soaking pit is placed in the ingot buggy in the as-cast position — in other words, with the piped end up. If rolled in this position, the finished slab is delivered to the shear with the piped end leading. This sometimes results in excessive scrap loss and off-length slabs because often more metal is removed than is necessary in cutting back to clean metal. If, however, the slab is turned and rolled butt end forward, the shearman cuts only enough metal from the front end of the slab to square it up. This results in a maximum of the excess metal being removed from the piped end.

THE UNIVERSAL ROLL STAND

This mill has been designed with the idea of maximum flexibility of operation in the rolling of ingots into slabs. The mill is of the universal type — that is, it consists of a horizontal roll stand and attached vertical mill. In addition, the horizontal mill has sufficient lift to permit rolling on edge, a feature which is often not included in slabbing mills of the universal type. The practice at Homestead is to bring the ingot into the

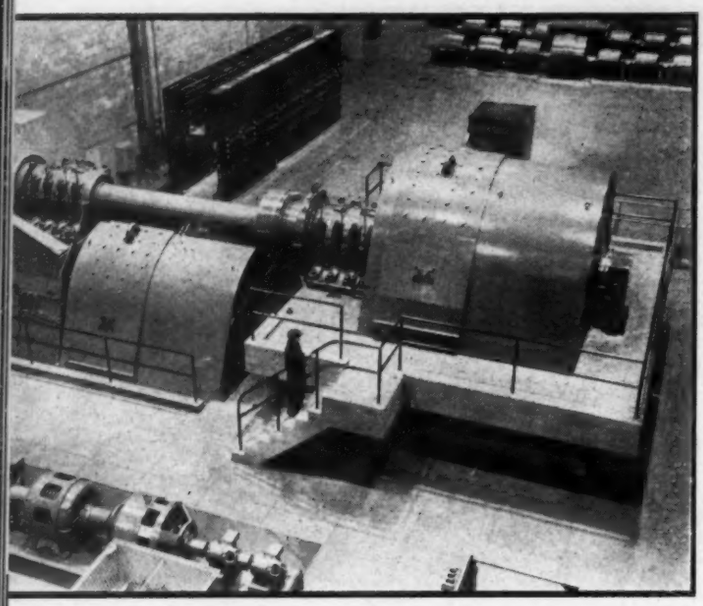


Figure 5 — The main drive is of twin design, with a 5000 hp motor connected directly to each horizontal roll.

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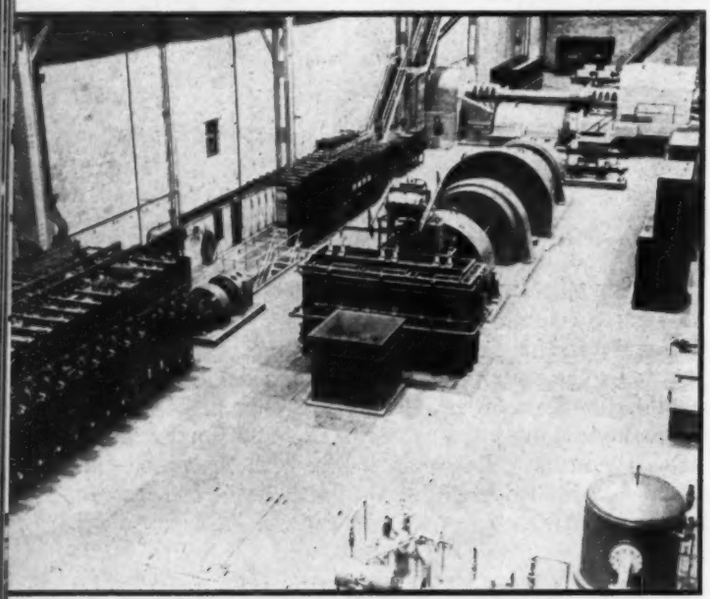
Figure 6 — View of slab mill motor room, showing switch gear, controls and motor generator set, with drive in background.



mill on edge for a scale breaking pass. Most mills of the universal type are made with plain side guards, but here again because of edge rolling, this mill is equipped with manipulator fingers on the delivery side of the mill.

The horizontal rolls for this mill are 45 in. in diameter by 80 in. long and are mounted in roller bearings. This is one of the unique features of this installation because this is the first primary mill of this type on which roller bearings have been used. Most of the older slabbing mills and a number of the newer mills use plain babbitt bearings. Quite a few of the newer mills have also used water-lubricated fabric bearings. It has been generally accepted throughout the industry that an expensive high precision bearing such as a roller bearing was more or less of a luxury as far as slabbing mill operation is concerned. This has not been found to be the case and we believe there is a real dollar and cents saving in the use of roller bearings. There is undoubtedly some savings involved from a power standpoint, but this is a minor consideration as far as the mill man is concerned. So far, definite savings have been indicated in bearing maintenance cost and (more important as far as savings is concerned) an absence of shutdown time for bearing changes or bearing repairs.

In addition, the roller finds it unnecessary to frequently check slabs for uniformity of thickness, while readjustments and frequent leveling of the rolls has been entirely eliminated. This has a definite value since it cuts down delays in mill operation. To sum up the bearing situation, the results obtained have been gratifying.

There were two questions about the use of roller bearings on a slabbing mill. The first was the design of a seal that would exclude both water and scale. Considerable thought was given to this problem by both ourselves and the mill builder, and we are glad to report that the final design decided upon has done an excellent job. The second question was possible damage to the bearings due to roll breakage. So far roll breakage has not been encountered on this mill, so results are not available. However, this is not too important a consideration, as roll breakage has occurred on the 100 in. reversing plate mill at Homestead without damage to the roller bearings.

Being a high lift mill, the screwdown has a very high operating speed. The screws are 18 in. in diameter with 2¼ in. pitch and are geared to travel at 26 fpm at 615 rpm of the screwdown motors.

Roll changing is accomplished by means of a motor-operated roll-changing rig. The entire roll assembly, including top and bottom bearings and chocks, is removed simultaneously.

The mill rolls are direct driven by two 5000 hp motors through universal spindles. Both the top roll and the spindles are balanced by a counterweight arrangement. Mill roll speeds are 470 to 940 fpm. Reversal of this mill is extremely rapid as it can go from base speed to base speed in three seconds.

THE VERTICAL MILL

The vertical mill is of the attached type and is driven through overhead gear reduction units by a 3000 hp motor. This edging mill is based on a proven design in use for several years at the Edgar Thomson plant. It differs from most vertical mill designs in that the vertical rolls are separate from the drives and are connected by easily detachable couplings to facilitate roll change. This in a larger part has overcome the objection to earlier designs that required almost complete dismantling of the drive for roll changing. The overhead roll drives move with the edger rolls and are operated by the same adjusting drive as used for positioning the rolls. The rolls themselves are 36 in. in diameter, 80 in. long, with 22 in. diameter necks, and are mounted in bronze bearings.

MAIN MILL PULPIT

The mill pulpit is located on the delivery side of this mill. Mounted in the pulpit are the controls for mill

tables, manipulators, horizontal mill rolls and screwdown, vertical mill rolls and traverse adjustment, and also screwdown indicator and vertical mill adjustment indicator. The indicators are large dials indirectly lighted and enclosed in a glass-faced case. The two mill operators are seated in leather upholstered chairs which are provided with lateral and vertical adjustments. Pulpit windows are made of 1 in. thick glass and are the full depth of the pulpit to give maximum visibility. All facilities for the convenience of the operators have been provided, including wash room, drinking water, ample lighting, cleaned air taken from the motor room, and heavy insulation on the floor.

SCALE DISPOSAL

The mill scale disposal system at the Homestead slabbing mill is an innovation. It is a departure in many respects from customary methods in that it is a combination of a wet and dry system. It is designed for operation with a minimum of labor, with practically no power application, with a maximum of scale recovery, and with every reasonable means for safety in operation.

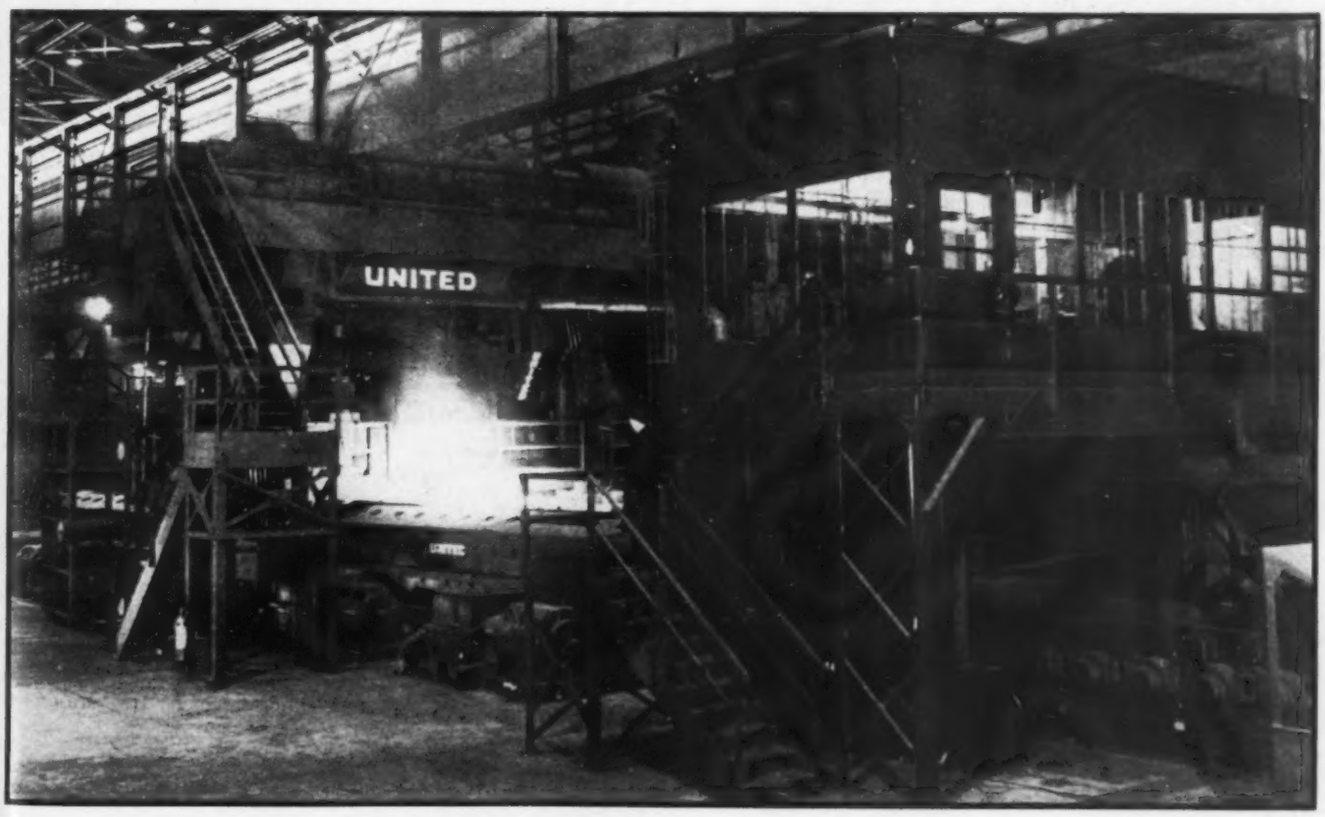
Running under the mill, beneath all table rollers from the ingot receiving table to the slab shear is a steel lined flushing flume, pitched downward from each end to a low point about 20 feet from the mill on the entry side. From this low point, the flumes converge in a ninety degree "Y" and from thence the flushing flume continues downward to a scale pit outside the mill building.

The scale pit is designed to store an unusual amount of scale, thus reducing the frequency of unloading. The water capacity of the pit is approximately 43,000 gallons, and it will accumulate up to 150 tons of mill scale before starting to pile above water line. The pit is unloaded with a 1½ yard two-line hook-on grab bucket with perforated scoops, handled by an overhead traveling crane. At Homestead, with the Monongahela River at normal stage, water from the scale pit flows away by gravity, but at flood stage this is impossible. To provide for this emergency a 6000 gpm sump pump has been installed to dispose of pit water by discharging to a high level storm sewer, after first having closed a back-wash sluice gate in the gravity sewer.

The flume under the mill tables, for its entire length, is paralleled by a passageway or work corridor which is protected by an overhead system of heavy steel deflector plates and curtain guards. The flume proper is two feet wide at the top and two feet deep, its sides sloping inward to a rounded bottom of 9 in. radius. The flume liner is of continuously welded steel plate, one inch thick and solidly grouted in concrete foundations. The flume is variously pitched at grades of 5¾ to 8⅓ per cent, with flow velocities of 17 to 21 fps. All water for flushing is washed from coolers and other equipment, and the amount used varies from 4500 to 5000 gpm. For a certain continuous length, where heavy scale falls, the top of the flume is fitted with lateral grids; these are 5 x 2 inch billets set on 8 inch centers. Heavy pieces of scale dropping from the mill or between table rollers fall upon these grids and shatter, the small pieces dropping between the grid bars to be washed down the flume.

Dry scale disposal refers to the handling of pieces too large to fall through the grid bars over the flume. The floor of the corridor alongside the flume is depressed to convenient working levels. Over this corridor and under

Figure 7 — The mill is operated from a roomy, well lighted and well ventilated pulpit located on the entry side.



the protecting deflector plates a longitudinal monorail beam carries two manually operated twin chain hoists of special design, riding on trolleys. Each twin hoist carries a collection tray having hooks which fit over the edge of the flume in such a manner as to enable the operator, using a hand grapple, to drag heavy scrap off the grids onto the tray. Loaded trays traverse the monorail by hand hauling to a dumping station. This station is a chamber formed in the concrete foundations, which is in fact merely a widening of the work corridor. In it are two cradle shaped cars riding on tracks set in the floor and running at right angles to the flume. From the flume to the back of the chamber the depth is just sufficient to place the cars, when in the back position, under an open well in the mill floor. Through this opening, the mill crane lowers an open hearth charging box to the cradle of each car. Cars are moved forward by hydraulic mechanisms to a point where scrap trays can dump their loads directly into charging boxes. When filled, the cars are shifted back into the lifting position under the open well.

The fact that the heavy scrap is directly loaded into open hearth charging boxes is one advantageous feature of the Homestead system, but the principal advantage of this combined wet and dry system is that it positively prevents any clogging of the flume; there are no chutes nor hoppers into which material may be wedged, and with reasonable attention no mill shutdown will occur because of faulty scale disposal. One man alone handles the dry collection and yet has time to keep the floor of the corridor clean. The corridor is well lighted and ventilated. It is believed this combined wet and dry system has the mill scale disposal problem solved.

SCARFER

Located between the mill and the shear is an oxyacetylene scarfing machine designed to remove relatively thin layers of steel from the vertical edges of hot slabs ranging from 3 in. to 8 in. in thickness. It consists of two similar cutting units, mounted on carrier plates suspended from independent motor driven carriages so that they can be retracted from the roll table line for maintenance and repair. The scarfing machine is controlled from the operating pulpit located alongside the mill table, whence all operations are initiated by means of an automatic operation switch located on a control table. Push button stations for operation of the various auxiliaries for the hot scarfer, such as circulating water pump, high pressure water pump and smoke removal fan, are located on the benchboard. A tachometer mounted on the control panel indicates the speed of material passing through the machine.

The correct number of scarfing nozzles for varying thicknesses of slabs are selected by the operator through a switch on the control tables. A selection of any number of nozzles from 3 to 7 is possible by means of the nozzle selector switch.

It should be noted that the nozzles used in hot scarfing have a definite limit as far as good surface quality of scarfed steel is concerned. If the appearance of the steel is not important, the machine can operate at a table speed of 100 fpm with oxygen pressures up to 45 psi

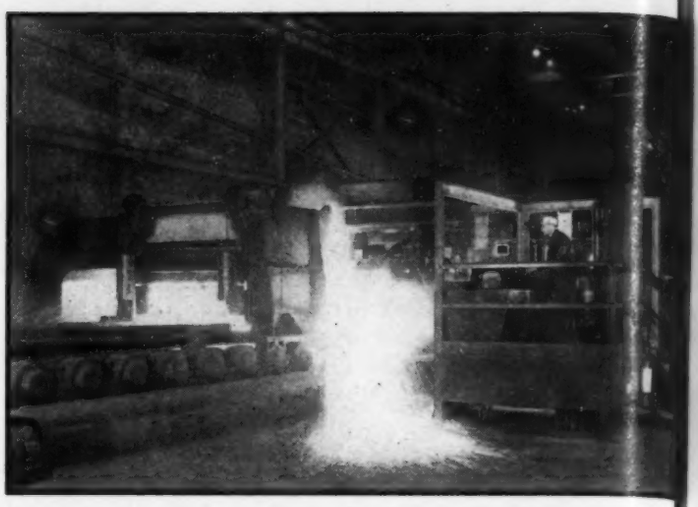


Figure 8 — The edges of the slabs may be hot-scarfed in any oxyacetylene scarfing machine located between the mill and the shear.

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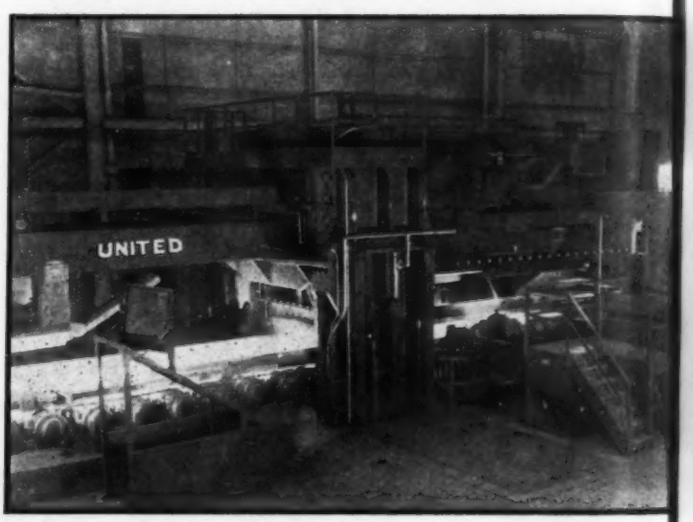
Figure 9 — The slab shear, of upcut design and hydraulically operated, can cut sections up to 20 in. x 62 in.



or higher. A fairly smooth surface is obtained with these conditions, but the surface will be marred with grooves if the pressure is increased much above 45.

The performance of this machine is a definite saving in material and manhours over work that previously was done by hand scarfing.

UPCUT SLAB SHEAR

Next in line is the slab shear which is a hydraulically operated upcut shear for cutting sections up to 20 x 62 inches, and will handle lengths up to 20 feet. On the entry side of the shear is a motor-operated crop pusher for removing rear crop or for pushing short slabs through the shear. On the delivery side of the shear is a motor-operated shear gauge.

The maximum opening between knives is 27 inches. The top knife head is adjustable by means of a motor-operated screwdown. This is a decided advantage in that the knife opening can be adjusted to suit the thickness of slab being cut, and the stroke of the bottom knife need only be enough to cut the slab. The top knife head is hydraulically balanced and pull-back cylinders

are provided for returning the bottom knife head. A 1000 psi weighted type accumulator system furnishes pressure for these cylinders as well as for a hydraulic slab holddown, which prevents cocking of the slab during the cutting period. The top knife head and bottom knife head pull-back cylinders are under constant pressure and at the completion of the up stroke of the bottom knife, the main valve is opened to exhaust and the pull-back cylinders return the lower knife head to its bottom position. This being an upcut shear, the bottom knife is moved upward through its cutting stroke by a 40 in. diameter cylinder. The hydraulic power for this operation is supplied by three horizontal duplex plunger pumps, each having a capacity of 317 gpm at 4500 psi pressure. Any one or all of the pumps can be operated, depending upon the speed at which the operator wishes to cut. Each pump, as mentioned earlier, is independently driven by a 400 hp, 750 rpm motor. A flywheel on the high speed shaft insures positive, smooth action during peak load conditions. The selection of the pump or number of pumps in operation is made by the shear operator from the shear pulpit. The shear will cut up to its maximum capacity of 20 x 62 inches with two pumps running. As a result, one pump may be down for repair without hurting mill production. Since the top knife head can be adjusted for various thicknesses of slabs, the bottom knife will not always make the same length of stroke. Mounted at the back of the shear is a limit switch arrangement for unloading the pumps at the time the knives have overlapped about ½ inch. Should the limit switch fail and the bottom knife continue to move upward, a cam operated pilot valve will cause the main hydraulic valve to open to exhaust, thus allowing the lower knife to return to its bottom position. This shear has lived up to every expectation. It operates very smoothly and produces an excellent cut which is surprisingly good on even the thickest of slabs, and slabs up to and including 20 inches thick have been sheared.

CROP DISPOSAL

On the delivery side of the shear there is a pull-back table which in its retracted position allows space between the shear and the first table roller for crops to drop through. In its forward position it facilitates the handling of short slabs which would otherwise drop into the opening for disposal of crop ends. Crops drop through this opening on to a chute which delivers them to a flight type crop conveyor.

This crop conveyor is on an incline and carries the crop out of the mill building into the scrap yard and discharges the crops down a delivery chute to the scrap yard floor. Here the crops are handled by crane tongs directly into open hearth charging boxes. This method of handling crop ends was selected because of its aid in properly segregating the many grades of steel rolled in this plant.

SLAB PILING

The next thing of interest is the slab piling arrangement. The piling arrangement consists of a tilting table, the tilting feature of which is hydraulically operated, and three motor driven cars, two of which are located directly at the end of the tilting table on the same track, and a third some distance away. No. 1 and 3 cars are used for transporting slabs into the adjoining slab yards. No. 1 car does the bulk of this work, slabs being piled directly on this car from the tilting table. All cars have capacity for two piles of slabs. Slabs are run off the end of the tilting table and slide out onto the car. Table height is adjusted for the next slab and so on until a complete pile has been made. In case of a hold up in operation of car No. 1, car No. 2 can be used for standby capacity and these slabs placed on car No. 1 or No. 3 by crane. Car No. 2 is longer than cars 1 and 3, and is used exclusively for a small percentage of slabs too long for cars 1 and 3. These slabs are stored in a slab yard at the end of the mill building and removed from car No. 2 by crane and placed directly in the slab yard for storage. Car No. 2 is wide enough for two piles of slabs, so that a second pile can be started before the first pile is removed. Car No. 1 does the big bulk of the slab

Figure 10 — Hot slabs are transferred from the mill to the adjacent slab storage yards by transfer cars.

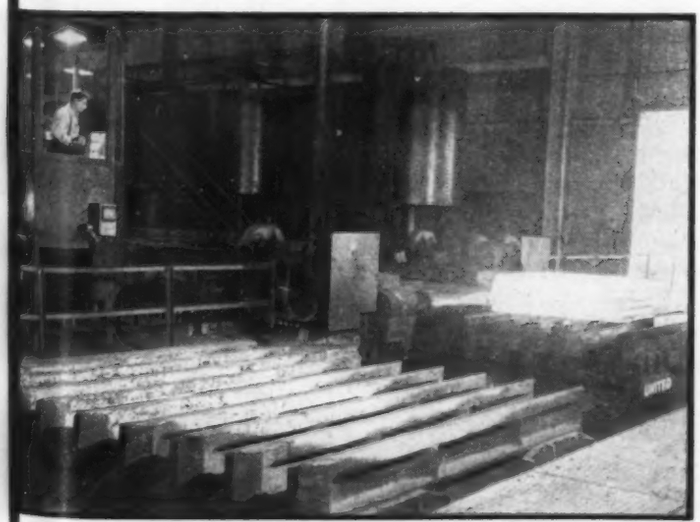


Figure 11 — Another view of slab transfer car at end of mill runout. The last table is arranged to tilt so as to line up with the top of the pile of slabs.

handling work and very seldom is it necessary to use either of cars 2 and 3.

Most slabbing mills employ a slab transfer for conveying slabs into the storage building, with a table and one or more pilers located in slab yard. The new Homestead arrangement is much simpler. Also, the tilting table and transfer cars have an advantage as far as first cost is concerned. It is recommended to anyone considering a new slabbing mill or the revamping of an old mill that this type of slab disposal be given serious consideration.

SLAB STORAGE

For storing of slabs, three storage yards are available. The so-called A and B yards are located at right angles and to the north of the mill, and are served by slab transfer cars 1 and 3. Slab yard C is a direct continuation of the mill building proper and is served by two 30-ton cranes.

About 110 ft of slab yards A and B are without roof, so that the great amount of heat from the hot slabs and the steam from water cooling the slabs can easily be dissipated to the atmosphere.

Scarfing docks for inspection, hand scarfing, and conditioning of slabs are located in the A and B yards. These scarfing areas are serviced by two gantry cranes of 10-ton capacity and 16 scarfing outlets in the A yard, and by one 10-ton gantry crane and 16 scarfing outlets in the B yard. Ten scarfing outlets, but no gantry crane, are provided for in the C yard. It is possible to condition approximately 400 slabs per turn in the A yard and about 250 slabs per turn in the B yard.

Slow cooling and preheating pits are located in all three yards to provide for special types of steel that require this form of treatment. Combined storage capacity in the three yards is approximately 100,000 tons of slabs.

Typifying the modern trend, the 45 in. mill is served by five oiling systems, one for each of the following:

1. Manipulators, edging stand, screwdown and feed roller drives.
2. Table drive and line shaft gearing.
3. Shear pumps.
4. Main mill drives.
5. Crop conveyor and pusher drives.

Motor-operated pressure grease systems with automatic time clock control, of which there are fourteen, serve the roll neck bearings, spindle bearings, mill tables, manipulators, slab turning device, shear, etc. Three manually operated grease systems lubricate ingot buggy, shear knife slides and retracting table.

Mention should be made that this is one of a few primary mills equipped with a high pressure scale removal system. This consists of two centrifugal pumps connected in series delivering 800 gpm at 1000 psi pressure at descaling headers located at the entry side of the mill.

Also not to be forgotten is the ventilation of the rotating electrical equipment in the motor room which is accomplished by down-draft, with closed recirculating system, containing surface type air coolers, returning the cooled air into the motor room. Make up air is drawn into the system from the outside through an electrostatic precipitator.

In closing, it may be stated that the steel rolled on the 45 in. slabbing mill is going into all kinds of fighting equipment for our armed forces, and is contributing to our victories over the Axis powers.

DISCUSSION

PRESENTED BY

T. R. MOXLEY, General Master Mechanic, Wheeling Steel Corporation, Steubenville, Ohio

A. G. ERICSON, Chief Engineer, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

H. L. HARPER, Staff Engineer, Aluminum Company of America, Pittsburgh, Pennsylvania

J. W. O'BRIEN, Assistant Chief Engineer, United Engineering and Foundry Company, Pittsburgh, Pennsylvania

H. D. ROBB, Division Manager, Timken Roller Bearing Company, Pittsburgh, Pennsylvania

J. B. MITCHELL, Superintendent of Mills, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

A. F. KENYON, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

F. S. BLOOM, President, Bloom Engineering Company, Pittsburgh, Pennsylvania

F. MOHLER, Engineer, Steel Mill Section, Industrial Engineering Division, General Electric Company, Schenectady, New York

T. R. Moxley: I would like to ask Mr. Ericson why the bronze bearings on the vertical rolls.

A. G. Ericson: I was afraid that that question might come up. I would like almost to ask the question myself. Some day I hope that we can get roller bearings on the vertical rolls too, and I am going to have some of my friends in the roller bearing industry take the bull by the horns and put roller bearings on the vertical rolls. I think it can be done. It is one of these things that perhaps we let go sliding by at times.

H. L. Harper: I would like to ask Mr. Ericson what difference, if any, in the horsepower that he suggested, was saved, and how he compared it with what type of bearings, when using roller bearings.

A. G. Ericson: We know that there is considerable saving due to the absence of the very heavy friction loads that we have on the conventional bearings, but as was mentioned in the paper, we did not pay too much attention to the power savings, although they could be appreciable. We are going to find out, however, how much horsepower we are saving when we get a little time so we can make the necessary power tests. Based on ordinary calculations, we should be able to save ten to twelve per cent.

The thing that impresses me about roller bearings is that we don't need to be too much concerned about lubrication. If we have the bearing surfaces bright and clean in a roller bearing, it still functions and performs

very satisfactorily for quite some time. But when we lack lubrication on a sleeve bearing, it doesn't take very long until the heat generates sufficiently to burn up the bearing, and the heat cracks your roll necks. So while I would be happy if I could answer the question directly on how much power saving we have, I am sorry to say that I can't. But we are going to make it the subject of a study and it is of sufficient importance that we should develop it. I definitely feel that the run-of-mine bearing is done for as far as mills are concerned. We have to go to better bearings. There is no question about that and we have, of course, good bearings in the industry today. We have the oil film bearing that has just as good features as the roller bearing when it comes to power saving and so forth, and I hope to see a slabbing mill with that type of bearing on it some day. We have it on these heavy plate mills today and I see no particular reason why our primary mills should be the step-children of our mill designers. After all, they turn out the tonnage, and we should give just as much consideration to the most advanced methods in designing of the primary mills as on finishing mills. So one of these days we will see slabbing mills with these fine oil type bearings too. They both have their place in the industry and I certainly would welcome such a design also.

We must not forget, too, that we have fabric bearings on the slabbing mills. In a very important mill just recently finished, they have fabric bearings — water lubricated fabric bearings — and they are doing very well. The main thing is to keep dirt and scale out of them and to provide them with good water. They give a good account of themselves also. I may be a little bit partial towards roller bearings. Homestead has had a very particular part in development of large heavy roller bearings. As you know, the 52 in. universal beam mill at Homestead probably was the first that had large roller bearings on the vertical rolls and we have been very pleased with the performance. Consequently we have had no real reason for departing from that particular practice. And when you study mills in general, you find that you apply roller bearings practically everywhere, on table rollers, line shafts, and everywhere else.

J. W. O'Brien: There are two things I would like to emphasize. First, in the use of roller bearings on a mill of this type, the question of seals is very important. If water and scale are kept out of these bearings, they should last a long time with very little maintenance. Sealing is especially important because of the use of high pressure descaling water. So far the seals on the Homestead mill have done a very good job.

The second thing I would like to mention is the use of the hold-down or gag, which Mr. Ericson mentioned in his paper, on the hydraulic slab shear. The good cuts obtained on this shear can be attributed in large part to the hold-down gag, as it counteracts the cutting action of the knives and prevents the slab from tilting up, consequently getting a much better cut.

This gag or hold-down has another important function, on an upcut shear. In cutting, the bottom shear knife raises the slab off the delivery table and when the cut is complete, the slab would drop on the table. That is not a good thing for the table, causing shock and consequently high maintenance. The gag or hold-down acts as a cushion and lets the slab down on the table with surprising ease. This is not very important on three or four or five inch slabs, but this shear cuts twenty inch thick slabs, and they will raise off the table twenty or twenty-two inches, and you just don't like to drop a twenty inch thick slab on a mill table

H. D. Robb: I would like to take this opportunity to publicly express appreciation to Mr. Ericson for specifying roller bearings on this mill. He has already stated that it was not the effect of any salesmanship that caused him to request roller bearings for this mill. We admit that when we were first approached we were sceptical as to the possibility of recommending a satisfactory bearing. Our reason for this was that we felt that, in order to get a bearing of sufficient capacity, it would be necessary to increase the diameter of the roll, and secondly, that we might have to reduce the neck to such an extent that there would be a danger of neck breakage. From a proposed rolling schedule, however, we were able to calculate the expected loads and much to our surprise, we found that we could recommend a bearing that would permit the same size roll as used on comparative mills. Our principal comparison was the Edgar Thomson mill, which is more or less a duplicate of this Homestead mill, and again much to our surprise, as far as the neck was concerned, we found that we could increase it an inch and a half over the Edgar Thomson mill. In other words, we have a 29½ in. neck as compared with a 28 in. neck at Edgar Thomson.

We have analyzed these loads and anticipate about the same life for the bearings on this mill as have been obtained on the 100 in. plate mill at Homestead. This mill has been in operation for about eight years with very satisfactory results.

We anticipated that we would obtain power savings. We expected, based on some of our past tests on smaller mills, that we would get savings of at least 20-25 per cent, and we hope that when this mill is analyzed this saving in power will be shown. We anticipated 50-75 per cent reduction in lubrication cost, as well as savings in bearing maintenance. I might state that to date we have examined three bearings. Two bearings we took out primarily for checking the seals. This is more or less of a radical departure in the seal design, and I am sorry that Mr. Ericson did not show this construction. The third bearing we removed for a thorough check. We are glad to report that all three bearings examined to date show that they are doing a very satisfactory job.

Roller bearings on the necks of merchant and bar mills easily permit of a product that can be held to one-half of the present commercial tolerances. Heretofore, we have not considered accuracy of gauge as of any particular importance on primary mills. We, therefore, were surprised to find that the operating men emphasized this point above all others.

I think I can answer that question in regard to the reason why roller bearings were not used on the vertical rolls. Many mill edgers are completely roller bearing equipped, including necks and drives. This mill edger is a duplicate of the one originally built for the Edgar Thomson mill on which roller bearings are used on the drive but plain bearings on the vertical rolls. When the original edger was designed it was endeavored to put roller bearings on the vertical rolls but it was found

that by so doing the outside diameter of the bearing necessary to carry the load would be so large that it moved the edgers about 9 inches farther out from the feed rolls. We believe that, with the newly designed bearing that we have been furnishing for many applications for the past couple of years, we might now be in a position to apply bearings on these rolls, but at the time this mill was designed we could not do it.

J. B. Mitchell: There are some questions which I would like to have Mr. Ericson answer:

1. Are your soaking pit covers of the suspended or sprung arch type?
2. Are your pits lined with brick or stone?
3. What water pressure have you found it necessary to use on your hot scarfing machine?
4. On your hydraulic equipment, do you use plain water, an emulsion, or pure lubricant as your hydraulic medium?
5. Have you developed a method for turning or grinding your rolls without removing the roller bearing?
6. What kind of a communicating system do you use between your rollers, recorders, shearmen, etc.?

A. G. Ericson: We have the suspended roof. It is a flat arch, suspended.

All of our pits are stone lined.

The water pressure on the scarfer is 150 psi.

On the shear we use a very light oil as the hydraulic medium.

We remove the roller bearings when we grind our rolls.

We use loudspeaking telephone communication between the key points in the mill.

A. F. Kenyon: The feature of the Homestead slabbing mill which attracts attention and which has already been discussed to considerable extent by earlier speakers is the use of roller bearings on the horizontal roll necks. I think equally important, although out of my line, are the scale disposal and slab handling systems, and it is apparent that a great deal of detailed attention was given to the design of all parts of this installation.

In connection with the use of roller bearings on the roll necks, the saving in power, as well as the other advantages, have been cited by the author. Although he has indicated that the power saving may be of relatively minor consequence as compared to other characteristics, still it does offer some rather interesting possibilities in considering the drives for such mills. If the power saving is 10, 12 or 20 per cent, or whatever it may be, it of course means that much saving in kwhr energy consumption and to that extent reduces the cost of operation of the mill. This may amount to a saving of perhaps only a cent or so per ton rolled.

More important, perhaps, is to consider that with the same drive equipment, heavier drafts may be taken, the rolling completed in fewer passes, and tonnage output increased; or if heavier drafting is not desirable, a smaller driving equipment may be used. In this case the twin-motor main drive is of 10,000 hp capacity, and with the indicated power saving of at least 10 per cent as compared with a similar plain bearing mill, it would appear that on the roller bearing mill the same work could be done with a 9000 hp drive. If the actual reduction in power is found to be more than 10 per cent, an even smaller capacity drive might be used. To us, as electrical manufacturers, this feature of the roller bearing application seems worthy of further study to determine to what extent the capacity of the motor drive equipment may be affected.

The reasons for not using roller bearings on the vertical edging rolls have been briefly touched on, stating that further bearing development was necessary in order to meet space requirements. The operation of many slabbing mills is restricted by the side drafts which may be taken, and even on new mills, limitations in the edging roll gear drives prevent applying as much power to the edging rolls as would be desirable. Improved bearings on the edging rolls, to effect an appreciable power saving such as indicated for the main rolls, would enable heavier side drafts and thus improve the overall mill operation.

F. S. Bloom: On this particular job, there is one correction that should be made regarding the soaking pit control. That is that we operate as a primary impulse the gas instead of the air. Originally, the pits were designed to operate from the air as a primary impulse on varying Btu gas, with the idea that it would give a constant fuel input if operated from the air. However, as the installations were made with this idea in mind, it was found that when the fuel-air ratio handwheel was adjusted, it changed the fuel rate to the pit. In other words, if the ratio handwheel was adjusted oxidizing, the fuel rate was reduced. If the fuel-air ratio handwheel was adjusted to the reducing side, the fuel rate to the pit was increased. This type of an adjustment caused considerable trouble. It confused the operators, because if a man thought he wanted a little more air on his pit, the ratio handwheel was adjusted to excess air, and he got a reduction in gas flow, thereby reducing the temperature of the pit. This confusion did not allow the heater to study the operation of the pits, and was the main change made on the Homestead job over that of Edgar Thomson.

F. Mohler: I would like to emphasize the ingot buggy which, as I understand it, weighs some 307,000 lb when loaded and is the largest ever built. It is also the first one to be equipped with an adjustable voltage drive, the first to be equipped with shunt wound motors, the first to be equipped with auxiliary exciter control, and the first to make use of photoelectric relays for indicating the position of the buggy.

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Blast Furnace Gas -

WET-WASHED OR DRY-CLEANED?

. . . . experience indicates that wet-washed gas, unless cleaned to .02 grains per cu ft or less, leaves deposits in the boiler which are more troublesome than those resulting from dirtier dry-cleaned gas . . . .

by F. X. GILG

BABCOCK AND WILCOX COMPANY
NEW YORK, NEW YORK

▲ BLAST furnace gas is inherently a dirt-laden fuel, the dust content depending upon the gas cleaning process being used. When boilers are operated with blast furnace gas alone, without supplementary pulverized coal or coke breeze, the heat absorbing surfaces become fouled with deposits which reduce the heat absorbing capacity and lower the efficiency of the unit. Unless these deposits are removed by sootblowers or hand lancing, the exit gas temperature leaving the unit rises to a point where it may become necessary or advisable to take the unit out of service for external cleaning. There will be deposits on the tubes regardless of whether the blast furnace gas entering the furnace carries 5 grains or .05 grains per cu ft of gas. The nature of the deposits, depending upon the gas cleaning method used, may be quite different and some will be very difficult to remove with sootblowers. We have obtained data from four plants using different methods of blast furnace gas cleaning showing the effect of dust deposits on the heating surfaces, the effectiveness of soot blowers and hand lancing in removing these deposits, the analyses of these deposits and the effect of supplementary pulverized coal firing on removing these deposits.

Figure 1 shows an integral furnace boiler in plant A designed for 100,000 lb of steam per hr at 200 psi pressure, with a superheater for 505 F total temperature on blast furnace gas, which is the base fuel. The burners are also equipped to burn coke oven gas and oil. The blast furnace gas is washed after it leaves the primary cyclone and then passes through an electrical precipitator. The dust loading of the gas leaving the precipitator is about .009 grains per cu ft. The boiler and air heater are equipped with soot blowers. Because of the extreme cleanliness of the blast furnace gas from the precipitator the soot blowers were not used at all during the first few months of operation. The temperature of gas leaving the air heater at normal load began to rise slowly and then soot blowers were used about once each week. Later, the soot blowers were operated once each day, and more recently the operators have found it advisable to use the soot blowers every 8 hr to keep the temperature of the gas leaving the unit under control. During periods when the wet washer or precipitator is bypassed or repaired, the soot blowers are operated every 4 hr. Although burner clean-out ports are provided, it is not necessary to clean the burners while the unit is in service. During out-of-service periods for internal or external cleaning, the furnace walls and boiler tube surfaces are cleaned externally with a combination tube scraper and air lance. At first the unit was taken out of service for external cleaning after 8 months operation; this was later stretched to 6 months. The most recent continuous operating period was 10½ months for each of the two boilers in

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

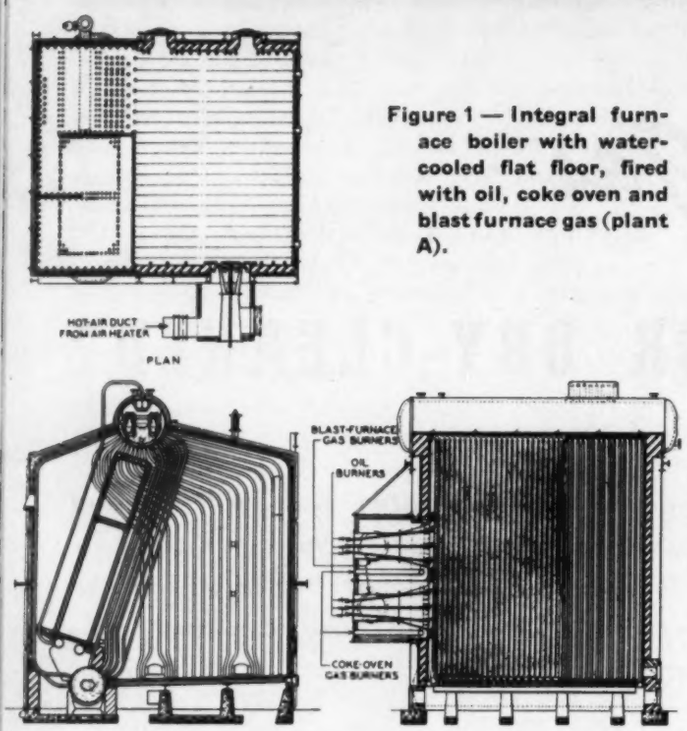


Figure 1 — Integral furnace boiler with water-cooled flat floor, fired with oil, coke oven and blast furnace gas (plant A).

this plant. Figure 2 shows the performance of the unit before and after external cleaning, after operating periods of 8 months and 10½ months. It is to be noted that the exit gas temperature at 92,000 lb of steam per hr was reduced about 150 degrees when this unit was returned to service after external cleaning.

Figure 3 shows the rise in gas temperature leaving the unit plotted against weeks of operation for the recent 45 week run. The gas temperature rises steadily for about 5 weeks and then is maintained fairly constant by blowing the soot blowers regularly. The drop in temperature when using the soot blowers is only about 10 degrees but this is sufficient to maintain almost equilibrium conditions. The run was continued for 45 weeks after which the boiler was taken out of service for general inspection and cleaning. The drop in load, as shown on the chart, occurred during the last 2 weeks of the run. The deposit on the tubes was soft and clung tightly to the tube surfaces, but was easily removed with an air lance. The soot blowers have an effective range of about 18 in. radius. The deposit around the burners was hard and had to be removed with a sand blast.

Figure 4 shows a similar integral furnace boiler in plant B designed for 150,000 lb of steam per hr at 225 psi pressure on blast furnace gas which is also washed and precipitator cleaned. The precipitators were designed originally to clean the blast furnace gas to .02 grains per cu ft. However, due to increased steam demands, the dust loading of this gas now is .06 grains per cu ft. This unit is now equipped with soot blowers but there are some hand lance doors through the roof of the unit. Due to the tenacious nature of the deposits on the heating surfaces, the absence of soot blowers and a shortage of labor which permits lancing by hand only once each week, the exit gas temperature from this unit climbs very rapidly. Because of burner fouling, requiring high gas pressures, it becomes necessary to reduce load after about 3 weeks of operation. The hard deposit which forms around the burners cannot be removed by barring through the burner clean out ports because of outside interference.

Figure 5 shows a time-temperature plot of a recent run of about 7½ weeks duration with a hand lance cleaning once each week. The normal desired operating period is about 15 weeks between outages for external and internal cleanings. However, recent average continuous runs between outages are approximately 7½ weeks so as to permit thorough cleaning of the burners so that higher steam loads can be carried. At the end of the run the gas temperature leaving the air heater is less than it was before load was reduced. While the data are not available, it is felt that the exit temperature of the gas could be prevented from rising above 725 F by vigorous hand lancing at daily intervals. The significant part of this curve is the rapid rise in gas temperature during the first few weeks of operation after the unit was cleaned externally. This is due entirely to the fouling of the surfaces and insufficient regular cleaning of these surfaces while the unit is in service. This shows the effect of fouling even though the gas is quite clean.

Figure 2 — Effect of external cleaning on exit gas temperature with blast furnace gas firing (plant A).

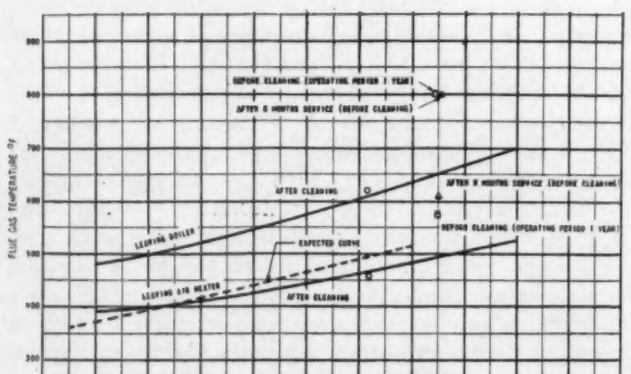
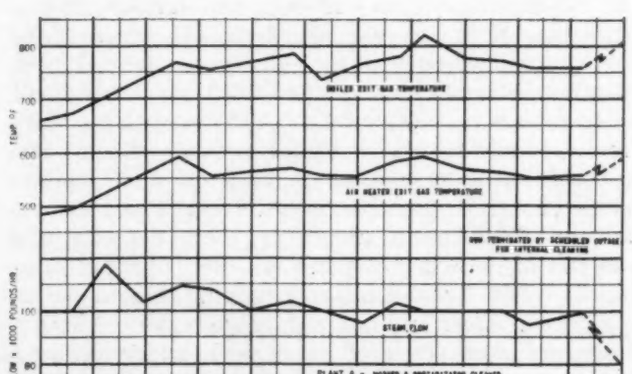


Figure 3 — Time-temperature plot for plant A with blast furnace gas firing.



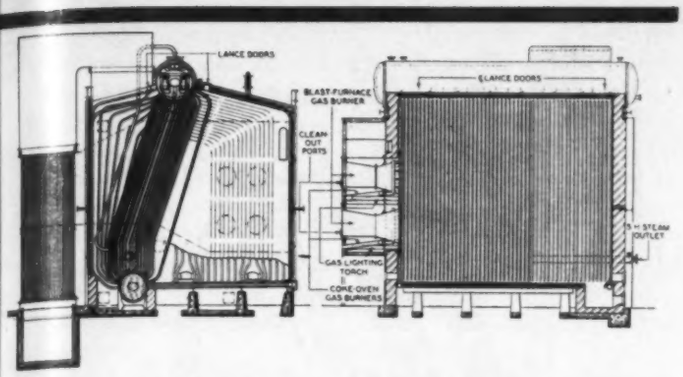


Figure 4 — Integral furnace boiler fired with blast furnace gas and coke oven gas (plant B).

Nevertheless, the .06 grain dust loading will result in about 7 times as much dust entering the furnace as compared to plant A with its .009 grains per ft.

In plant C there is a similar integral furnace boiler unit designed for 100,000 lb of steam per hr at 215 psi pressure on blast furnace gas firing, using hot raw gas after it leaves a set of multiple cyclone separators. The dust loading of the gas at the time this data was taken, was 2½ grains per cu ft. Most recent tests by the vendors of the dust separators are reported to show less than 1 grain per cu ft as a result of some field changes in this equipment. The boiler is equipped with soot blowers and lance ports in the roof over the second and third gas passes. The dirt entering this furnace is equivalent to the ash content of coal if pulverized coal containing 10 per cent ash were burned at the same steam output. Three to four inches of dirt collects on the furnace floor every 24 hours. While the tubes of the second and third pass are normally covered with about ¼ in. thick deposit, the accumulation is readily removed by the soot blowers which are operated several times each day. It is not necessary to clean the burner regularly through the clean-out ports while the unit is in service. The dirt from dry hot gas behaves differently from that from the wet-washed gas, in that it does not cling to the tube surfaces as tightly and is easily dislodged by the soot blowers or by hand lancing. A vigorous blowing of the soot blowers will reduce the gas temperature leaving the air heater as much as 100 degrees. On the other hand the gas temperature has been known to increase 40 degrees in 4 hr after a soot blowing period. Their normal operating period is about 90 to 100 days, after which the units are taken out of service for internal and external cleaning. This operating period is not limited by the external deposits, which can be kept under control with soot blowers supplemented by hand lancing. An inspection after a recent 90 day continuous run showed little need for external cleaning and the run could have been continued.

Figure 6 shows the effect on gas temperature after an external cleaning period, the gas temperature leaving the air heater being reduced 60 degrees at 100,000 lb steam per hr.

Figure 7 shows the time-temperature curve for a recent run. It will be noted that the gas temperature rises quite rapidly during the early weeks, and then cleaning by soot blowers and hand lancing maintains the gas temperature under control. The space between upper and lower curves represents the possible gas temperature drop after vigorous soot blowing and hand lancing.

For comparison with these boilers, Figure 8 shows a blast furnace gas fired boiler in plant D, designed for 100,000 lb steam per hr at 230 psi pressure, using a wet-washed but not precipitator-cleaned gas having a dust loading of .3 to .69 grains per cu ft. In addition to the blast furnace gas burners this unit is also equipped for pulverized coal firing. The soot blowers are operated every 6 hr, but these are not sufficiently effective to prevent the accumulation of a dense, hard scale. Supplementary pulverized coal firing is resorted to for 2 to 3 hr whenever the temperature of the gas leaving the air heater approaches 700 F. The abrasive action of the fly ash from pulverized coal firing has a scouring action on the blast furnace gas scale deposit on the tubes with the result that the exit gas temperatures are reduced from 20-60 degrees. The coal used is bituminous coal from the Pittsburgh No. 8 seam. During one period, the plant was operated for several days on pulverized coal and then went back to furnace blast gas firing with the result that the gas temperature leaving the air heater dropped from 720 F to 635 F, and the load, which was previously limited to 85,000 lb steam per hr because of excessive draft loss, went to 95,000 lb steam

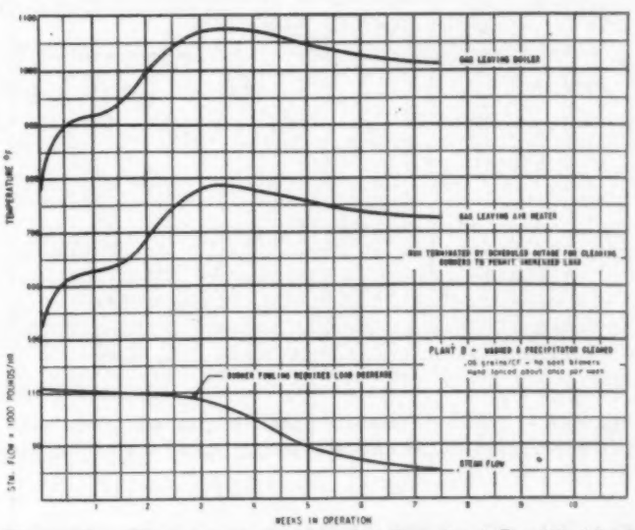
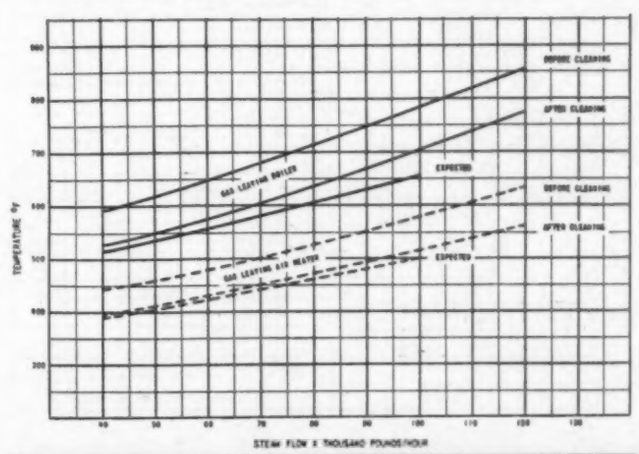

GAS LEAVING BOILER
GAS LEAVING AIR HEATER
PLANT B - WASHED & PRECIPITATOR CLEANED
BURNER FIRING REQUIRED LOAD DECREASE
STEAM FLOW
WEEKS IN OPERATION

Figure 5 — Time-temperature plot for plant B with blast furnace gas firing.

Figure 6 — Effect of external cleaning on exit gas temperature with blast furnace gas firing (plant C).



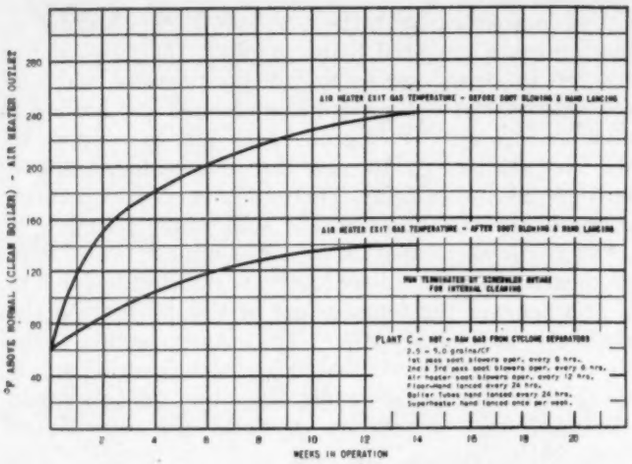
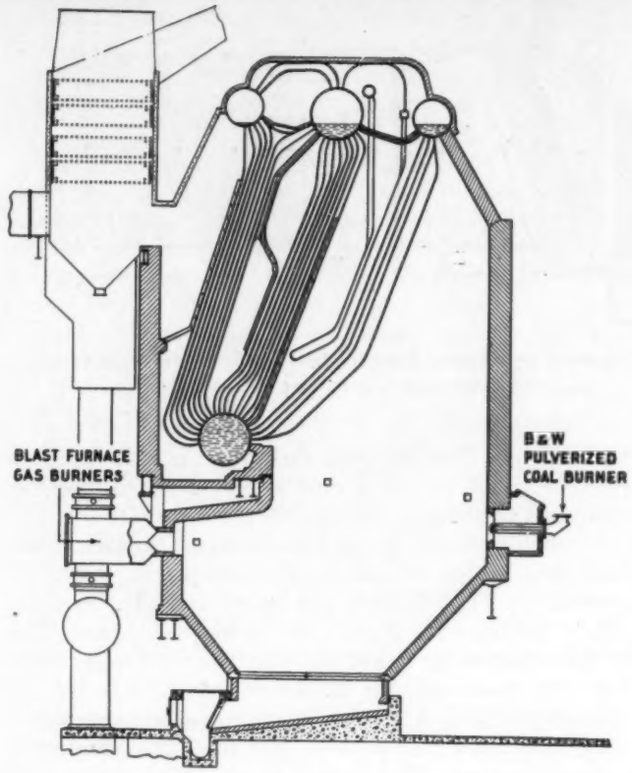

°F ABOVE NORMAL (CLEAN BOILER) - AIR HEATER OUTLET
AIR HEATER EXIT GAS TEMPERATURE - BEFORE SOOT BLOWING & HAND LANCING
AIR HEATER EXIT GAS TEMPERATURE - AFTER SOOT BLOWING & HAND LANCING
RUN TERMINATED BY SCHEDULED OUTAGE FOR INTERNAL CLEANING
PLANT C - HOT - RAW GAS FROM CYCLONE SEPARATORS
2.5 - 5.0 grains/CF
1st pass soot blowers oper. every 8 hrs.
2nd & 3rd pass soot blowers oper. every 8 hrs.
Air heater soot blowers oper. every 12 hrs.
Floor-wand lanced every 24 hrs.
Boiler Tubes hand lanced every 24 hrs.
Superheater hand lanced once per week.
WEEKS IN OPERATION

Figure 7 — Time-temperature plot for plant C with blast furnace gas firing.

Figure 8 — Boiler designed for blast furnace gas and pulverized coal firing (plant D).



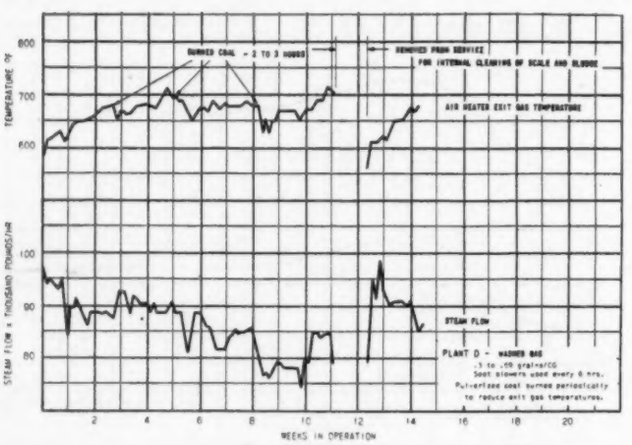
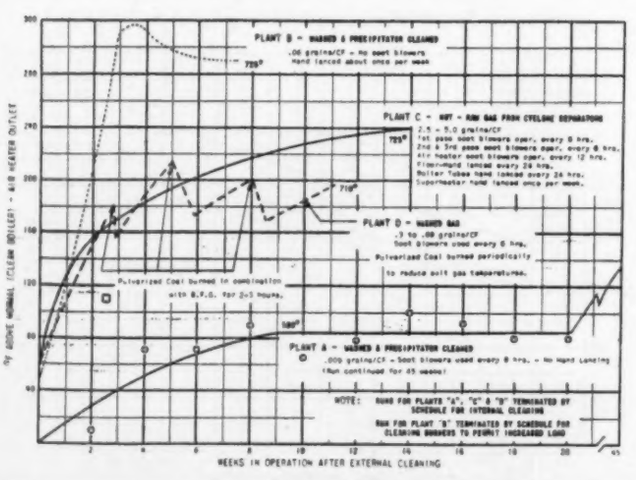

TEMPERATURE °F
STEAM FLOW - THOUSAND POUNDS/HR
BURNED COAL - 2 TO 3 HOURS
REMOVED FROM SERVICE FOR INTERNAL CLEANING OF SCALE AND SLUDGE
AIR HEATER EXIT GAS TEMPERATURE
STEAM FLOW
PLANT D - WASHED GAS
.3 to .09 grains/CF
Soot blowers used every 8 hrs.
Pulverized coal burned periodically to reduce exit gas temperatures.
WEEKS IN OPERATION

Figure 9 — Time-temperature plot for plant D, fired with blast furnace gas and pulverized coal.

Figure 10 — Composite plot from four plants, showing temperature rise above normal against time with blast furnace firing.


°F ABOVE NORMAL (CLEAN BOILER) - AIR HEATER OUTLET
PLANT B - WASHED & PRECIPITATOR CLEANED
.06 grains/CF - No soot blowers
Hand lanced about once per week
PLANT C - HOT - RAW GAS FROM CYCLONE SEPARATORS
2.5 - 5.0 grains/CF
1st pass soot blowers oper. every 8 hrs.
2nd & 3rd pass soot blowers oper. every 8 hrs.
Air heater soot blowers oper. every 12 hrs.
Floor-wand lanced every 24 hrs.
Boiler Tubes hand lanced every 24 hrs.
Superheater hand lanced once per week.
PLANT D - WASHED GAS
.3 to .09 grains/CF
Soot blowers used every 8 hrs.
Pulverized Coal burned periodically to reduce exit gas temperatures.
Pulverized Coal burned in combination with B.F.G. for 2-3 hours.
PLANT A - WASHED & PRECIPITATOR CLEANED
.009 grains/CF - Soot blowers used every 8 hrs. - No Hand Lancing
(Run continued for 45 weeks)
NOTE: RUNS FOR PLANTS "A", "C" & "D" TERMINATED BY SCHEDULE FOR INTERNAL CLEANING
RUN FOR PLANT "B" TERMINATED BY SCHEDULE FOR CLEANING BURNERS TO PERMIT INCREASED LOAD
WEEKS IN OPERATION AFTER EXTERNAL CLEANING

per hr. During out-of-service periods, the heating surfaces and burners are cleaned with a sand blast using fly ash as the abrasive material. The operating period normally is about 90 days after which the boiler is taken out of service for internal and external cleaning, the boiler using 100 per cent makeup water with all internal treatment.

Figure 9 shows the time-temperature plot for plant D and indicates the ineffectiveness of soot blowers in preventing an early rise in gas temperature during the first 3 weeks of operation; also, the effect of burning pulverized coal for short periods.

Figure 10 shows a composite plot of these four jobs which are tabulated in Table I. The gas temperature rise above normal is plotted against the operating period in weeks between external cleanings. This makes an interesting comparison because each job burns blast furnace gas which has been cleaned to different degrees of cleanliness. The plot shows that plant A, using the washed and precipitated gas with a cleanliness of .009 grains per cu ft, has the best record for continuous service. Plant B with the .06 grains per cu ft and no soot blowers has the most abrupt rise in temperature. This abrupt rise can undoubtedly be flattened out by greater attention to hand lancing at intervals closer than once per week. However, it is to be noted that wet-washing and cleaning in a precipitator to .06 grains per cu ft is not clean enough to offset the greater difficulty of removing the more tenacious deposits which form on the burners and heating surfaces. The supplementary cleaning of the gas in a precipitator should approach the .009 grains per cu ft of plant A. A figure of .02 grains per cu ft might be suggested as a maximum limit and even then soot blowers and hand lancing will be necessary at regular intervals. Temporary slips in

the blast furnaces or temporary bypassing of the precipitator, even for only ½ hr, will discharge much mud that will bake on the burners and tubes. Therefore, it is very important to keep the precipitators in continuous service. We have some indication of this from plant D, where there is no precipitator and where the deposit is like a hard scale. Plant C shows that the deposits from dry, dirty gas, even though much thicker, are fairly easy to remove with soot blowers. The burners need never be cleaned in service because of the absence of the tenacious deposit which forms from the wet-washed gas.

Samples of deposits from the heating surfaces of three of these boilers have been subjected to laboratory analysis, and the results are shown in Table II.

At plant C, where dry cyclone separators are used to clean the gas, we have a deposit which is easy to remove and which contains approximately 4 per cent sodium sulphate, 70 per cent iron oxide and 12 per cent silica. At plants A and D where wet-washing of the gas is employed, the deposits from each are similar in character and contain approximately 38 per cent sodium sulphate, 17 per cent iron oxide and 13 per cent silica. It is quite apparent that the question of easy removability of blast furnace gas dust hinges on the content of sodium sulphate and more particularly on the ratio of sodium sulphate to iron oxide, which has higher fusing points. This condition is reflected in the fusing temperature points, which are higher for the deposits with the higher iron and lower sodium sulphate content. The dry cyclone separator is permitting large quantities of iron oxide to pass on through. Wet-washing on the other hand reduces the iron oxide content and at the same time permits sodium sulphate from the wash water to be carried through to the boiler surfaces.

The experience from these four plants and others not tabulated herein indicates the deposits from wet-washed blast furnace gas, even though thoroughly cleaned in a mechanical or electrical precipitator to .06 grains per cu ft, are more difficult to remove while in service when boilers are operated on this fuel alone. The deposits from wet-washed gas are of finer texture and cling to burners and heating surfaces like a cement or scale, whereas the deposits from a dry cleaned gas do not bake on the burners and are easier to remove from heating surfaces with soot blowers. Therefore, unless wet-washing is followed with precipitators which will thoroughly clean the gas so that it will contain no more than .02 grains of dust per cu ft and extreme care is taken to avoid the necessity of bypassing or overloading the precipitator even for short periods, dry cleaning of blast furnace gas is to be preferred. The extent of dry cleaning will depend on how much money one can afford to invest for dry cleaners as compared to the

TABLE I—Operating Conditions

Plant	A	B	C	D
Normal steam load, lb per hr	100,000	110,000	100,000	90,000
Steam pressure, psi	200	225	215	230
Steam temperature, F	505	520	500	549
Btu liberated per cu ft of furnace volume	23,300	20,500	23,200	16,600
Pounds of flue gas per sq ft of free area between tubes of second and third gas passes	4,200	3,530	4,180	4,720
Feedwater conditions	10 to 20% makeup. River water. Hot process lime-soda.	100% makeup. River water. Hot process lime-soda. 10% blowdown.	80% makeup. River water. Hot process lime-soda. 3 to 5% blowdown	100% makeup City water. Internal treatment 7% blowdown.

TABLE II—Blast Furnace Gas Dust Analysis

	Plant A	Plant C	Plant D
Type of blast furnace gas cleaning	Wet washed precipitator cleaned, .009 gr per cu ft	Hot raw gas from multiclones, 2.5-5 gr per cu ft	Wet washed, .3 to .69 gr per cu ft
Calcium oxide, CaO	8.2	3.5	7.1
Iron as Fe	12.0	49.1	11.9
Iron as equiv. Fe_2O_3	17.1	70.2	17.0
Total sulphurs as SO_3	21.0	Not determined	22.2
Equivalent sodium sulphate, Na_2SO_4	37.3	4.	39.4
Silica, SiO_2	13.0	12.	13.0
Analysis by material			
Coke	3.9	0.7	0.2
Limestone	8.2	3.5	7.1
Equivalent sodium sulphate	37.3	4.0	39.4
Ore (by difference)	50.6	91.8	53.3
Total	100.0	100.0	100.0
Fusion temperatures in reducing and oxidizing atmospheres			
	Reducing Oxidizing	Reducing Oxidizing	Reducing Oxidizing
Initial deformation, F	2130 2200	2200 2680	2110 2360
Softening	2160 2380	Indefinite	2180 2460
Fluid	2180 2550	2410 2820	2230 2680
Sizing, per cent through 325 mesh	74.8	96.4	48.

investment and operating cost of hand lancing and soot blowers. In any case, soot blowers supplemented by hand lancing is the most effective way of cleaning units fired with blast furnace gas. Supplementary fuels with abrasive ash, such as pulverized coal and coke breeze, scour the heating surfaces free of blast furnace gas dust, provided the introduction of either one of these fuels does not in itself introduce additional slagging problems.

DISCUSSION

PRESENTED BY

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A. G. WITTING, Carnegie-Illinois Steel Corporation, Gary, Indiana

F. E. KLING, Assistant Chief Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

F. X. GILG, Service Department, The Babcock & Wilcox Company, New York, New York

P. R. Duffey: We find Mr. Gilg's paper of particular interest to us as we have installed in our high pressure steam generating station at Indiana Harbor Works a large two-drum integral furnace steam generating unit fired with raw, wet-washed, dirt-laden blast furnace gas of about 88 Btu per cu ft as fired, and containing from 0.50 to 1.50 grains of dirt per cu ft as fired. This wet gas is fired alone with very little difficulty and with a minimum of burner cleaning. When gas is fired in combination with pulverized coal, there is improvement in firing conditions.

In a second plant at South Chicago we have installed three two-drum integral furnace steam generating units fired with hot saturated/dry, dirt-laden blast furnace gas of about 88 Btu per cu ft as fired, and containing 0.70 to 1.50 grains of dust per cu ft as fired. A low of 0.55 to 1.15 grains has been obtained. This hot, saturated/dry, dirt-laden gas is partially cleaned before firing by passing the gas from the dust catcher through a multi-tubular dust collector. Gas enters the cleaner at about 7 grains per cu ft. Mr. Gilg refers to this cleaner as a dry cyclone separator which is an erroneous term in this particular case.

I do not believe that today the gas is loaded to more than 0.60 to 1.25 grains entering the burners. The generating units can be kept clean externally by frequent use of mechanical soot blowers and hand lancing, so that they may operate continuously for six months between scheduled clean-up outage.

In all of our other steel plants where blast furnace gas is available as fuel for firing steam generators, it is used in a more or less raw state, i.e., wet-washed or hot saturated/dry gas. At none of our steam generating plants do we use a precipitated clean gas.

I am frank to state that while precipitated or otherwise thoroughly clean blast furnace gas is preferable for steam generator fuel to the so-called dirty gas, it is doubtful if the cost of high grade, expensive cleaning facilities can be justified, in the light of our own experience.

J. L. Miller: The subject of cleanliness of blast furnace gas for boiler firing has been given much thought by operators in the industry but to my mind not nearly enough by the people who sell the burners. The manufacturer knows the gas we have to use, yet he continues to build a burner with no apparent thought of how it is to be kept reasonably clean in operation on the gas which has been specified to him.

In the old days of wet-washed blast furnace gas and small boiler units — usually with aspirating type burners — there was many a headache but it was not the problem of today where units are so much larger and outage time for these larger units is at a premium. Dry cleaning of the gas was used some, very successfully so far as burning was concerned. The big problem was removal of the dirt deposits from the boiler proper and this resulted in considerable outage.

With our present larger units we must have clean gas and we have come to think of this as the equivalent of a precipitator cleanliness of .02 grains per cu ft. With this gas we must prepare for the cleaning of the very fine particles of flue dust which deposits on the tips and around the outlet of the burner.

We should, therefore, require boiler companies and burner manufacturers to work more closely with us in an effort to build a blast furnace gas burner that can be readily cleaned in the course of operation and does not require complete outage of the boiler unit to accomplish.

D. W. Whitehill: At Aliquippa we have our slag problems. We do not use wet-washed gas in boilers. We have a hot gas that is cleaned through cyclone separators to about ¾ to 1¼ grain per cu ft. As Mr. Gilg indicated to you, we do not have any trouble in our burners with plugging. However, we do get considerable scale and slag on our boiler tubes. We have three boilers that give us particular concern. They are all cross-drum boilers that we operate at about 300 per cent rating. When we operate at those ratings, burning blast furnace gas and powdered coal simultaneously, we form a slag on the tubes. We range from 40 per cent of our fuel to 60 per cent blast furnace gas and coal, as the operating conditions require us to do, and we form a thin scale on the tubes. Then the thin scale becomes covered shortly with a thick spongy material that in a few hours of operation at 300 per cent will completely close off the boiler passes.

We find that soot blowers are not effective in removing all of that material. We have found that we get considerable help from hand lancing and if it were not for the hand lancing that we do, we could not keep the boilers on the line.

H. W. Neblett: This paper clearly points out the advantages derived in burning clean blast furnace gas in modern boiler installations. The data presented on the operation of boilers using clean gas as compared with gas only partially cleaned clearly shows a decided advantage in prolonged efficiency of operation over

longer periods and less labor costs in cleaning boilers when blast furnace gas is used that has been cleaned to a point where the dust content is .009 gr per cu ft as compared with gas containing .05 or more grains per cu ft.

This conclusion is further substantiated by the experience with similar installations at the Inland Steel Company. There we have a boiler installation using blast furnace gas, coke oven gas and oil. The blast furnace gas is cleaned by wet-washers and precipitators, similar to the installation described by Mr. Gilg under plant A. We also have a boiler installation using blast furnace gas and powdered coal as fuel. The blast furnace gas in this case is cleaned by wet-washers only, similar to the installation described by Mr. Gilg under plant D. These two conditions show results of boiler operations quite similar to the conclusions drawn in this paper. In the case of wet-washer and precipitator cleaned gas we have not experienced any slagging on the boiler tubes that would necessitate hand lancing or special cleaning of any kind other than the use of soot blowers. At this plant we have ample precipitator capacity installed which eliminates overloading of gas cleaning equipment at all times. This, we think, is conclusive proof that properly cleaned blast furnace gas can be used in boilers continuously without experiencing trouble from slagging of the tubes. The installation using blast furnace gas that is cleaned by wet-washers only and is burned in combination with powdered coal deposits considerable slag on the boiler tubes which requires periodic hand lancing; also it is necessary to clean the hard deposit of dirt from the blast furnace gas mains and burners.

The question of the expense of installing sufficient gas cleaning equipment, such as precipitators in combination with wet-washers to insure clean gas at all times, naturally has to be considered. In considering this capital expenditure, it must be borne in mind that the benefits of clean gas not only apply to the boilers as has been pointed out in this paper, but to all gas piping and the blast furnace stoves as well. The benefits derived from the elimination of labor for cleaning the gas mains and blast furnace stoves, as well as the increased efficiency of the stoves, should also be taken into consideration when considering the increased cost of more efficient blast furnace gas cleaning equipment.

B. M. Herr: I believe there has been a great deal of development in the last four or five years in dry dust cleaning and I urge you to give the dry dust collector manufacturers a chance to show you what they have done in the way of development. I wish you would think more seriously how dust collection is affected by particle size in both mechanical and electrical precipitators.

A. G. Witting: About thirty-five years ago, I became convinced that the proper way to prepare blast furnace gas for combustion purposes was to wet-clean it by passing it through washers and, when necessary, through disintegrators. The reason is simply this: that blast furnace gas under ordinary furnace operation, leaving the furnace at temperature of 350-450 F, carries with it 50 to 60 grains of water vapor and sometimes more. This vapor will, during the process of combustion, have to be converted into steam, wasting 10 to 12 per cent of the Btu in the gas.

The primary function of the washers is to remove some of this vapor by precipitation as the gas is cooled. I may say that ordinarily the temperature of the gas leaving the preliminary washers ought to be reduced to 85-80 F. At that temperature, the full saturation is about 12 grains of vapor. In addition, due to the velocity pressure, gas also carries about 3 grains of entrained moisture, making the average total of 15 grams. Assuming at the start 60 grams, then 75 per cent of the water has been removed, and although considerable sensible heat also has been removed, the gain in combustion efficiency is important.

I must confess that I am not familiar with the latest development of dry cleaning equipment, cyclone dust catchers, electric precipitators, etc. I do not doubt that such equipment is far superior to washers in removing the dust. But dry cleaning does not remove any aqueous vapor as the temperature of the gas must be reduced to a temperature below 150 F before any of the vapor is precipitated. Consequently, the combustion efficiency of dry cleaned gas is lower than that for wet cleaned gas.

As a rule, the gas, after cleaning, is conducted a considerable distance in bare gas mains to the points of utilization and, at least in winter time, the temperature of the gas is further lowered below the saturation point, which means condensation of vapor. I dare say that this might be the case whether the gas is dry cleaned or wet cleaned, and the result will be precipitation of slush in the burners as well as in the mains.

I may be wrong in this assumption, but the argument still remains that, if the aqueous vapor in the gas is not removed by cooling, the heating efficiency of the gas is lessened by more than 10 per cent. The merit of dry against wet cleaning will then depend on whether the absence of entrained moisture and resulting slush in the burners offsets the loss of heat value.

However, my arguments in favor of wet cleaning do not end with this. The nuisance of entrained moisture ought to be overcome. I once thought that I had solved the problem by means of a heat exchanger in which the hot raw gas entering at 350-450 F was reduced to about 225 F, while the washed, cooled gas was raised from 80 F to 160 F. This temperature gave a very ample margin against saturation. As the entrained moisture was vaporized, the gas was perfectly dry and gave at the burners the impression of being very clean. The arrangement worked all right for a short time. Then we encountered troubles of various kinds and the scheme was finally abandoned. But I still believe that the idea is good and such an arrangement perfectly feasible, and I present it to you of the present generation as something worth your studies. Gas passed through an efficient design of washer and then reheated will be clean enough for any stove or boiler burners, will have higher combustion efficiency and will leave the burners clean. Gas used in combustion engines or for heating purposes in furnaces or coke ovens should, after having been preliminarily cooled in a washer, be passed through an electric precipitator which will remove the remaining dust as efficiently as any other apparatus and, besides, remove all the entrained moisture, retaining its low temperature.

F. E. Kling: Mr. Gilg's paper is of great interest to me because his experience with blast furnace gas coincides with mine. My experience, however, is not recent, it dates back to the period between 1915 and 1930.

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At one of our plants there were two boiler houses, just exactly alike, in which gas was used from two blast furnaces which were identical with the exception of the gas cleaning facilities. The gas cleaner of No. 1 furnace was of the dry type, steel wool being used as a cleaning medium, delivering a gas with a dust load of half to one grain per cu ft of gas. No. 2 furnace was equipped with a washer, cleaning the gas to .15 grains of dust per cu ft.

In the boiler house at No. 1 furnace no trouble whatsoever was experienced with the burners, and the dust collected on the boiler tubes was soft and could be removed readily by a steam lance. In No. 2 boiler house the two attendants were busy all the time scraping the sludge from the burners and hard, sintered dust from the boiler tubes. Also, the temperature in the combustion chamber was lower and the stack temperature higher than in No. 1 house.

Contrary to the claims made by wet washing advocates, about 10 per cent more steam was generated with the dry cleaned gas than with the washed gas. I then came to the conclusion that gas to be used under boilers should be dry cleaned.

A great deal has been written and said about the moisture in blast furnace gas, but it is not as bad as it may appear when we consider that the moisture constitutes only a small portion (11 per cent) of the gas compared with the other inert ingredients, carbon dioxide 12 per cent and nitrogen 50 per cent, or a total of 62 per cent. The sensible heat of the gas is of greater value for combustion than the effect of the vapor.

The action of moisture during combustion is not as has been pictured by many. Let us see what happens to the moisture when passing through a boiler setting. Assuming that the gas enters the combustion chamber at a temperature of 300 F and passes to the stack at 300 F, the moisture is superheated in the combustion chamber and desuperheated on its way through the boiler; there is, therefore, no loss of heat due to the moisture.

Now let us visualize this same procedure in connection with wet-washed gas. The gas enters the combustion chamber at 90 F laden with only about one-half the amount of moisture in the dry cleaned gas (a washer does not remove all of the moisture and usually adds more or less entrained water). Thus the heat required to bring the water and gas up to the 300 F exit temperature is lost.

In the old days, when stack temperatures were 900 to 1000 F or even higher, the conditions were different, as even with the dry cleaned gas there was a loss of heat in gas and moisture carried away at the higher temperature.

The cost of installation of dry cleaning facilities is considerably less than that of washers; also the cost of operation is very much lower. Other advantages include less pressure loss, negligible power consumption, no water required, no river or lake polution and therefore no dredging of rivers or lakes, and finally, less floor space is required.

F. X. Gilg: It is not the writer's purpose to express a preference for one method of cleaning over another. We are simply presenting the data as reported from several plants to show the results of different methods of cleaning blast furnace gas. We hope this data will be of some help to steel plant designers of the future.

THE Blast Furnace Skip Hoist - II.

. . . . continuing the discussion of modern arrangements of skip hoist drives which began with the author's paper of two years ago . . . .

by GORDON FOX, VICE PRESIDENT
FREYN ENGINEERING COMPANY
CHICAGO, ILLINOIS

▲ THIS paper relates to adjustable-voltage control for blast furnace skip hoists. It does not, however, constitute a blanket recommendation of the use of this type of control, nor will it attempt to evaluate the merits or demerits of adjustable-voltage control in comparison with contactor control operating from a constant-voltage system. It is recognized that, for reasons adequate or otherwise, adjustable-voltage control will be preferred in some instances. It is therefore fitting and proper that we consider certain aspects of the application of adjustable-voltage control to the distinctive requirements of blast furnace skip hoist service.

The discussion relates to conventional two-skip charging and is confined to hoists equipped with two-motor drives. The advantages of the two-motor drive, especially the full dual-drive, are so numerous, so definite and so evident that the single-motor drive for blast furnace skip hoists seems to be following the steam engine drive into the realm of obsolescence. This is evidenced by the fact that 80 per cent of the new skip hoists installed at large blast furnaces in the United States and Canada during the recent wartime expansion are of the two-motor variety.

In a paper presented before the Association of Iron and Steel Engineers two years ago ("The Blast Furnace Skip Hoist," A. I. S. E. Yearbook 1943, p. 150), the writer pointed out that a dominating factor determining the size of the hoist motors is the torque required in starting and accelerating. The torque demanded during this period, while the skip at the furnace top does not provide counterbalance, is about twice as great as the torque required under full-speed running conditions. In that paper it was argued that we should take cognizance of this important fact. A drive was described, using series-parallel control for the lower portion of the speed range and shunt-field control of the hoist motors for the upper portion of the speed range. This combination affords basically a maximum torque production per ampere at low speeds and diminishing torque capacity at high speeds. It permits use of higher gear ratios and it employs motor capacity far more effectively than conventional drives having the same torque capacity at all speeds.

A new type of Ward-Leonard drive has been evolved which conforms to the same basic principles. In this drive, adjustable-voltage is employed for the lower portion of the speed range only and shunt-field control of the hoist motors is employed for the upper portion of the speed range. A simplified scheme of connections for a drive of this kind is shown in Figure 1. A single 600 volt generator is used, feeding two hoist motors connected in

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

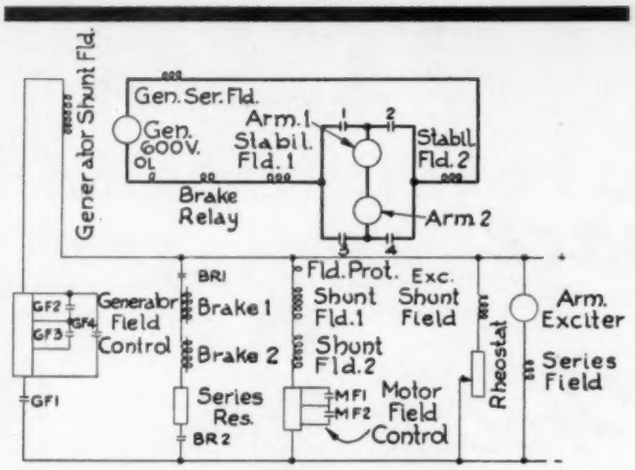


Figure 1 — Simplified scheme of connections for skip hoist drive using a combination of adjustable voltage and shunt field control.

Figure 2 — Charts showing speed regulation and generator field excitation of two drive systems.

series. Provision is made to vary the strength of the generator field in order to vary the voltage. The two brakes are connected in series across the exciter bus. The two shunt fields are similarly connected in series, and resistors and relays are provided to vary their strength.

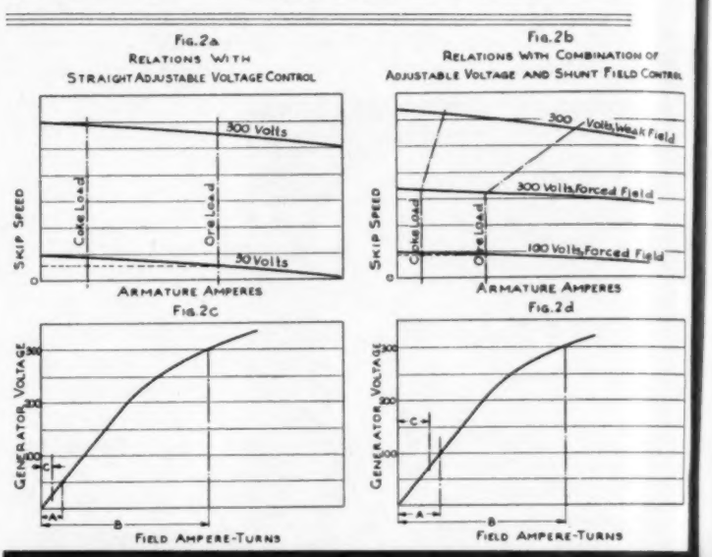
It should be particularly noted that the generator fields are not reversed and the generator voltage is consequently unidirectional. The direction of rotation of the hoist motors is changed by armature-reversing contactors (which are opened and closed only under zero voltage and zero current conditions). This arrangement is employed because the motors are equipped with stabilizing windings. The current must always flow through these windings in the same direction. These windings are essential to the stable operation of the motors with weakened fields.

The gear ratio between the motors and the hoist drum is substantially greater than in conventional practice. In view of this fact, and also because field-forcing is used at low speeds, motors of a given frame develop more torque at the hoist drum per armature ampere. The more effective use of the motors is reflected in more advantageous employment of the generator capacity.

It is standard practice for a blooming mill drive, for instance, to use voltage variation for the lower half of the speed range and shunt-field control for the upper half of the speed range. This is done because the torque requirements at low speeds exceed those at high speeds. It is recognized that, if voltage control were employed for the entire speed range, the drive, having inherently a constant torque characteristic, would not be well suited to its inverse torque load. Larger, more expensive equipment would be required or else torque capacity at low speeds would be sacrificed. The drive would be an economic misfit.

For similar reasons, the combination of shunt field control with adjustable-voltage control is more logical for blast furnace skip hoist service, than adjustable-voltage control alone. The advantages which accrue from its employment are similar to those which apply to the blooming mill, though on a less grandiose scale.

The combination of motor shunt-field control with adjustable-voltage control enjoys a further substantial advantage with respect to speed regulation at the dumping speed. Figure 2 has been prepared to illustrate the factors involved. Figure 2-a indicates the slightly drooping speed regulation of the shunt motor of a conventional adjustable-voltage drive when operating at full speed with 300 volts across the armature. It also indicates the effect of this regulation at low-speed with about 50 volts across the armature. The IR drop in the generator and motor armature circuits is a substantial part of this 50 volts. As a result, the dumping speed with an ore load may be half the no-load speed and about two-thirds of the dumping speed with a coke load.



Furthermore, the hoist may stall if it is called upon to handle an abnormal ore load.

Figure 2-b illustrates the corresponding conditions when a combination of motor shunt-field control and adjustable-voltage control is used. Because half of the speed reduction is obtained by shunt-field control, the armature voltage need not be reduced to so low a value, hence the effect of IR drop is relatively less. Furthermore, less armature amperes are required at low speed to develop a given torque at the hoist drum because of gear ratio and forced fields. For this reason, the IR drop is still further reduced. Consequently, the speed regulation inherent in this type of drive is decidedly better than that resulting with straight adjustable-voltage drive.

Figure 2-c shows the degree to which the field excitation of the straight adjustable-voltage generator must be reduced in order to reduce the speed as shown in Figure 2-a. Excitation A is perhaps one-eighth of excitation B. Excitation A is so small that it is not practical to subdivide it into shunt field excitation C and series field excitation such as A minus C. In other words, the generator cannot well be overcompounded to compensate for the IR drop. This deficiency has been overcome in some controls through the use of special schemes for excitation of the generator, using one or more auxiliary exciters, some of which may be provided with a multiplicity of field windings. Such schemes have been described in the technical press.

Figure 2-d illustrates the corresponding conditions when a combination of motor shunt-field control and adjustable-voltage control is used. The excitation need not be reduced to so low a value and the required proportion of series ampere-turns is less. Under these conditions the generator can be satisfactorily overcompounded to compensate for IR drop and the necessity to use more devious and complex methods can be avoided.

It may be noted from Figure 2-b (which refers to the adjustable-voltage, shunt-field control combination), that there is a considerable droop in speed under running conditions. This is due to the use of the stabilizing field windings on the hoist motors. Because of this drooping speed characteristic, it is feasible to operate the two motors in parallel rather than in series. Figure 3 shows the general scheme of connections.

Parallel connection of the hoist motors offers advantages, one or two of which will be discussed. One advantage relates to single-motor operation in emergency.

Let us consider the case of two skips each weighing 15,000 lb handling routine ore loads of 20,000 lb. When starting with two motors (without the benefit of the counterbalance of the skip at the furnace top), each motor may be said to hoist one-half the weight of the down-skip plus its ore content, that is, 7,500 lb of skip plus 10,000 lb of ore, or 17,500 lb total. When a single motor is used, it falls heir to the entire burden of starting the unbalanced skip itself, weighing 15,000 lb. In addition, it must hoist the contents of the skip. Comparison of the 17,500 lb figure and the 15,000 lb figure indicate only a small margin of motor capacity available for hoisting material. Thus, if a sizable ore load is handled, a relatively heavy demand is imposed on the single motor.

In an arrangement such as is shown in Figure 1, in which the two hoist motors are connected in series, the generator voltage is restricted to 300 volts when operating with a single motor. This constitutes, in effect, a reduction of 50 per cent in generator capacity. In order to handle the exceptional load imposed when operating with one motor, the generator must be oversize. This shortcoming also applies to the arrangement which has been employed, in some instances, in which the motor-generator set is provided with two generators, each feeding one hoist motor.

In an arrangement such as is shown in Figure 3, in which the two hoist motors are connected in parallel, the full capacity of the one generator is available to handle a single motor if and when the need arises. Therefore, it is not necessary to provide an oversize generator to meet this occasional condition.

A novel arrangement has been installed at a group of three new blast furnaces at a western plant, in which a single three-unit motor-generator set is located in the hoist house at each blast furnace. The set comprises a 600 hp synchronous motor driving two duplicate generators. One of these generators is rated at 250 kw, 300 volts. This generator supplies adjustable-voltage for the two motors driving the skip hoist. The other generator is rated at 200 kw, 240 volts. This generator supplies the constant potential direct current service to the scale car, cranes and other auxiliary drives about the furnace.

The general scheme of connections is illustrated in Figure 4. It will be noted that the two direct current generators are provided with transfer switches. Ordinarily generator G2 will be connected to the hoist motor bus and will supply adjustable-voltage to motor armatures M1 and M2. The fields of this generator are then controlled by resistors R5-R9 and by relays GF-GF3. Ordinarily generator G1 will be connected to the constant-voltage bus. It furnishes the excitation for the fields of all the machines. The brakes are also fed from this circuit. A number of feeders are provided to supply auxiliary motors in the local furnace area. The voltage of generator G1 is controlled by a hand rheostat.

In the event that a fault should develop in direct current generator G2, the transfer switches may be thrown to connect generator G1 to the adjustable-voltage hoist motor bus. The generator field transfer switches are also thrown so that the fields of generator G1 are controlled by resistors R5-R9 and by relays GF-GF3. Generator G1 can then serve as a full replacement for generator G2. Two alternative sources of adjustable voltage for the hoist motors are thus afforded.

If generator G1 is employed to supply adjustable-

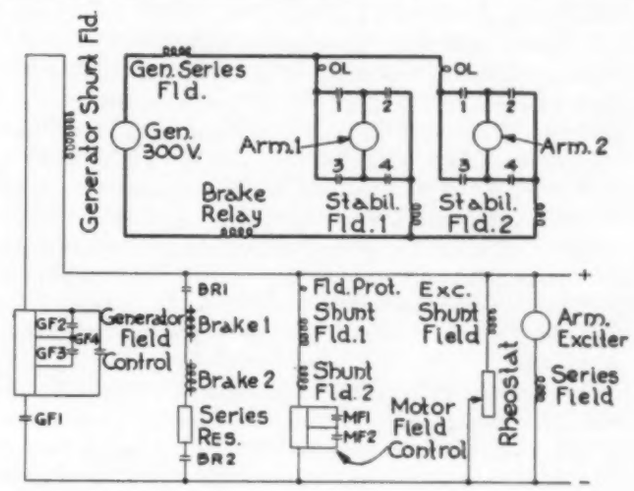
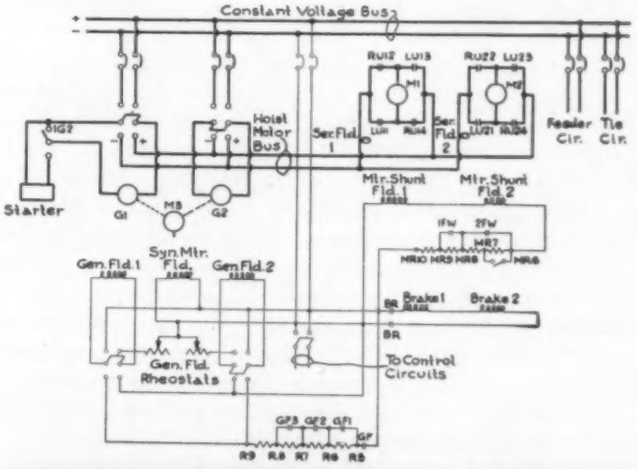


Figure 3 — General scheme of connections with two drive motors operating in parallel rather than in series.

▲

Figure 4 — Scheme of connections in installation containing a second generator, as installed in a western plant.



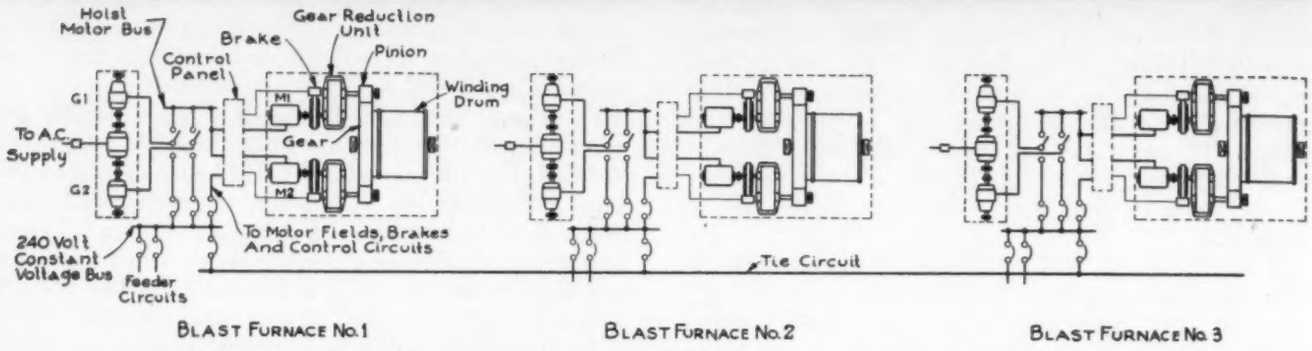


Figure 5 — Single line diagram of the system shown in Figure 4 as applied to an installation of three furnaces.

voltage, it is necessary to provide some other source of constant potential direct current. This is done by means of a tie circuit to which the constant-voltage busses at all three blast furnaces may be connected. The arrangement for the three furnaces is shown in single line schematic manner in Figure 5. The tie circuit is extended to a nearby substation which can supplement the direct current interchanged between the blast furnaces themselves, if need be.

Direct-current unit G1 is also provided with a resistor bank and starting contactors which enable it to be operated as a motor, if need be. These are indicated in Figure 4. Generator G1 may then be employed to drive generator G2. Generator G2 then functions in its normal manner to supply adjustable voltage to the hoist drive motors. This arrangement protects against the contingency of a fault in the synchronous motor or in the alternating current supply line or in the switching. To permit the synchronous motor to be removed for repairs, if need be, a spare section of dummy shaft is provided.

One more combination is possible, namely, that in which the two generators G1 and G2 are both connected to the constant-voltage bus. Such an arrangement is feasible only if the blast furnace with which these units are associated is shut down.

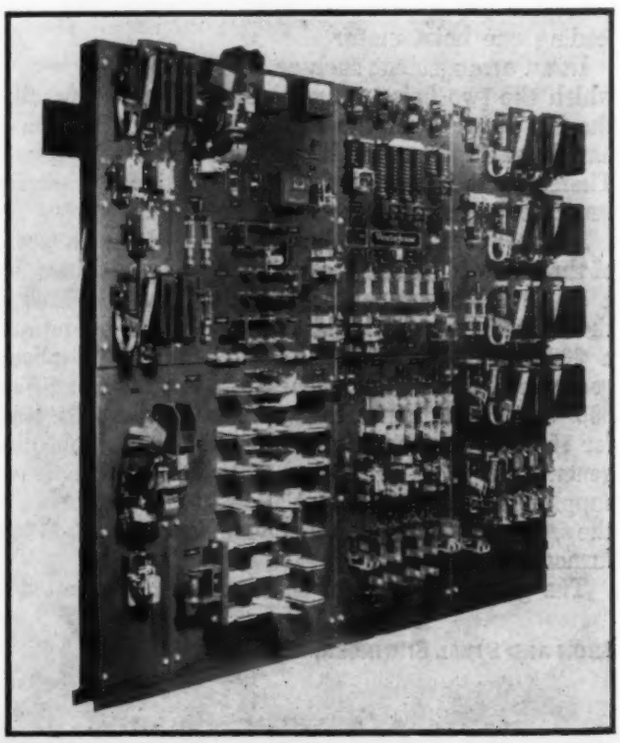
The appearance of the control panel for the direct current circuits is shown in Figure 6.

The above-described combination was well adapted to the conditions at this particular plant in view of the absence of ore bridges and unloaders in the immediate blast furnace vicinity. It is believed to have considerable merit in that continuity of operation is fully insured through duplication of facilities, with a total of five rotating armatures and without the installation of any idle reserve equipment. All of the ramifications of the scheme have been tried out and their merits demonstrated, although it has not been necessary as yet to employ any of the reserve arrangements.

The type of Ward-Leonard control which was described in earlier paragraphs of this paper, notably that in which the two hoist motors are operated in parallel as shown in Figure 3, is similar in many respects to the control as presented in the writer's paper previously mentioned. Figure 7 in that paper referred to magnetic contactor control operating from a constant-voltage system. The armature circuits are similar, the motor field circuits are substantially identical, the brake circuits are the same, the protective circuits are nearly the same. The principal difference between the two schemes rests in the fact that, for operation on a constant-voltage system, series-parallel control is employed for starting and for the lower portion of the speed control range. For operation as a Ward-Leonard drive, adjustable-voltage from a separate source of supply is used for starting and for the lower portion of the speed control range.

Because these two schemes of control have so much in common, it is feasible to provide a combination control which can be used either upon an adjustable-voltage system or upon a constant-voltage system. Such a control would normally operate as a Ward-Leonard arrangement, supplied with adjustable-voltage from the generator of a motor-generator set. In the event of failure of any element of the motor generator set, or of the alternating current supply or of the alternating current switching, the control would be transferred to the constant-voltage system which supplies the other direct current requirements around the blast furnace. The general scheme of connections of a combination control such as described is shown in Figure 7. While a number of variations of the general scheme are possible, this

Figure 6 — View of control panel, the connections of which are indicated in Figure 4.



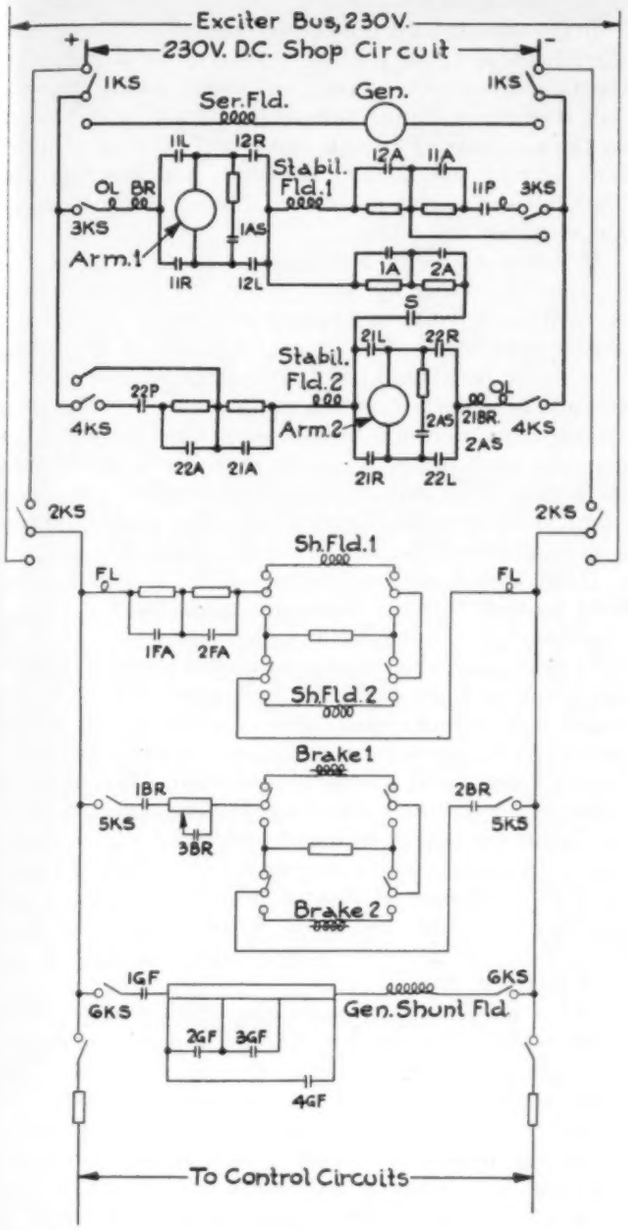


Figure 7 — General scheme of connections for a combination using series-parallel control with adjustable voltage.

figure will serve to exemplify the principles involved. The diagram shows at a glance the double-throw switches for transferring the motor armature circuits from the adjustable-voltage generator supply to the constant-voltage shop supply. It will also be noted that the field circuits, the brake circuits and the small-current control circuits can be connected either to a constant potential exciter bus for Ward-Leonard operation, or to the constant-voltage shop circuit for emergency operation.

The combination requires that accelerating resistors be provided for series and for parallel operation of the motors. A single armature shunt step is also shown for each motor. The diagram as shown contemplates that the armature shunts will be employed in connection with the adjustable-voltage control. Such an arrangement is contributory to an effective dynamic braking action.

As yet, no installations have been made of the adjustable-voltage drive with constant-voltage reserve, as described. Only the combination is new, however, as the performance of the adjustable-voltage and the constant-voltage component controls has been amply demonstrated.

It will likely be argued that, if the constant potential direct current system at the blast furnace is to be relied upon as an emergency source of supply for the skip hoist, a very substantial reserve of capacity must be provided. It is true that there should be some marginal capacity but its amount is likely to be overestimated. It is not as yet generally realized how drastically the demand on the power system has been reduced through the use of high gear ratio, forced fields and the series-parallel, shunt-field speed control scheme. Furthermore, it should be appreciated that the hoist speed when operating in emergency from the plant direct-current supply can easily be restricted below that normally employed when operating with adjustable-voltage control. This reduces the power demand.

One of the major disadvantages of adjustable-voltage control rests in its dependence upon the integrity of the additional links represented by the motor-generator set, switching, exciters, etc. If duplicate units are installed as a protective measure, they represent a substantial and almost completely idle investment. In view of the rarity of the need, the use of the existing direct-current system as the reserve would seem to be rational and economical. The scheme above described, together with dual-drive of the hoist, affords broad protection, simply and with modest cost.

I would like to present for your consideration a resume of the merits and demerits of skip hoist supply from constant-voltage and from adjustable-voltage systems. I would like to suggest to what extent and under what circumstances the use of the adjustable-voltage system seems to be warranted. I would like to present some views with reference to the proper speed of skip hoists, the capacity rating of skip hoists and the relations of the skip hoist movements to the blast furnace charging operation as a whole. It would seem better, however, that these questions be deferred until another occasion.

DISCUSSION

PRESENTED BY

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F. R. Burt: This paper is an interesting sequel to Mr. Fox's paper of two years ago in which he discussed

the use of motors having approximately 2:1 speed adjustment by field control but supplied from constant-voltage. Since systems of both types are now in operation a comparison of the results would be of interest and we will look forward to a third paper in the series touching on the points mentioned in Mr. Fox's closing paragraph.

Theoretically, it should be possible in a variable-voltage system to obtain quite flat speed regulation at reduced voltages by the proper compounding of the generator. However, we must be sure that under no condition is this over-compounding enough to result in a rise in motor speed with increase in load. Certain variables affect the overall regulation, such as change in IR drop with temperature, change in effective brush position due to wear, etc. In addition, since machines of this type are seldom provided with compensating or pole face windings, neither the generator nor the motor regulation curve is a straight line, nor are they symmetrical with respect to a straight line. Therefore, a generator with fixed over-compounding can compensate only to a limited extent for droop in motor speed, and in order to avoid instability under certain conditions, considerable droop in speed may have to be tolerated under other conditions.

If this speed droop is sufficient to cause inaccurate stopping under different conditions of load a remedy would be to use a shunt wound generator controlled from a rotating regulator. Such a system automatically compensates for IR drop, residual voltage and generator regulation and results in practically flat regulation at all voltages.

A point with regard to the installation mentioned in the paper which might be of interest, although it does not affect the hoist operation, is that the 2300 volt incoming line, tie and lighting transformer circuit breakers in the hoist houses are equipped with supervisory control. The dispatcher has an indication as to whether the 2300 volt bus in each house is hot and an indication of the position as well as complete control of each of the above breakers.

C. P. Hamilton: Mr. Fox's paper presents an interesting and somewhat new viewpoint which, however, is neither conflicting with previously expressed views nor of controversial nature.

In determining the proper drive for a skip hoist, considerably more is involved than just the question of providing motors and an opening system to simply meet the torque requirements and the nominal duty cycle. These factors are important, however.

As pointed out in the paper, the motor size must be determined from the maximum torque requirements. A skip hoist installation is essentially a torque proposition requiring, of the motor, maximum torque when the loaded skip is in the pit and a materially decreasing torque as the skip progresses on its trip. In fact, when a skip of coke reaches the dumping horn, torque values may become negative. The selection of motors should take this inherent characteristic of blast furnace skip operation into account.

As also stated in the paper, the trend is very definitely toward the use of two-motor drives. To the best of my knowledge, there have been only three single-motor skip hoist installations made in this country in the last four years. This very small percentage confirms the trend and indicates the general recognition of the advantages of two-motor drives.

In the two-motor drive, the selection of motor size and the scheme of operation will be determined first by the torque requirements of the hoist under maximum rope pull conditions during normal operation, and second by the adequacy of a single motor and the compromises that may be tolerated in the hoist, and hence in the blast furnace operation, in case it is necessary to operate with only one motor.

If two motors are used having a speed range of approximately 2 to 1 by field control, the inherent character of the drive, from a torque per ampere standpoint, closely matches the torque requirements of the hoist. The choice between a constant-voltage scheme of control and an adjustable-voltage scheme of control is then largely a question of hoisting speed. Most modern high capacity blast furnaces require skip speeds of 400 fpm or higher. The adjustable-voltage system has been found most successful for such hoists due to the superior controllability of the dumping speed of the skip.

If two motors are used having a 2 to 1 speed range by field control, there is some advantage from a torque standpoint in eliminating or in decreasing the extent of field weakening when one motor is used alone. If operating conditions are such that half speed with a single motor will be adequate, then connecting the motor armatures in parallel across the one generator armature makes a very good scheme of operation. There may be cases, however, where a prolonged delay in getting back to two-motor operation might occur and where operation with a single motor at greatly reduced speed might lead to a substantial loss of production. The writer recalls a particular case in which the ability to operate with a single motor at normal speed proved to be well justified.

If two motor armatures are connected in series across a single 500 volt generator, it is not necessary to reduce the voltage with single motor to, say, 250 volts. Mill type motors will operate satisfactorily with 400 volts or 450 volts across their armatures. By this means a single generator can be used at or near its normal current and voltage rating with single motor drive.

As pointed out in the paper, it is quite desirable to use stabilized shunt motors for adjustable speed service in order to be sure of sufficient load regulation over the entire load range so the motors will share the load. While in some cases shunt wound motors may be used without the stabilizing series field, caution must be taken to be sure that there is no hump in the regulation curve which would tend to pull the motors apart.

The use of the adjustable speed type of motor, with adjustable-voltage control, as described in the paper, permits the use of higher motor speed, and hence higher gear ratios, without the use of a relatively high voltage generator. Further advantage in the greater flexibility of operation of the motors is also obtained.

There is also the very important advantage, brought out in the paper, that speed regulation is greatly improved during the dumping of the bucket by using the combination of field weakening and armature voltage control, since the influence of the IR drop becomes very definitely of minor importance as indicated by reference to the two curves of Figures 2-a and 2-b.

E. J. Posselt: Mr. Fox presented a very clear and

concise picture of various schemes used on recent skip hoist drives. He proposes a new combination of adjustable-voltage and constant-voltage control which appears to take advantage of the desired features of each with a minimum amount of equipment. Elimination of excess rotating equipment was brought to your attention.

It may be noted that most of the control equipment is used either for normal or emergency operation. It is not necessary to provide additional standby controllers which might otherwise affect savings made possible by this new combination. The a-c control equipment would be the same as that required for any variable voltage starter. The d-c control equipment is the same type used throughout the mill and can readily be serviced without long delays. The flexibility of the scheme provides for cutting out various sections of the controller to permit continued operation during normal maintenance periods.

Since the cost of the controller is only a small part of the total cost of the electrical equipment, any additional material necessary to obtain the desired features brought out by Mr. Fox will be negligible. It is believed the merits of this new combination warrants serious consideration for future skip hoist drives.

Gordon Fox: I am quite in agreement with Mr. Hamilton that the selection of a skip hoist and its drive and control involves many considerations. This paper was confined to a few aspects of the total picture. The subject is too large to cover all of its ramifications in one session.

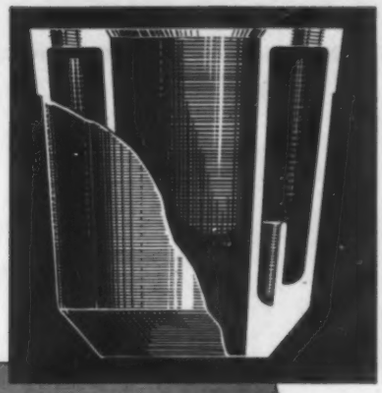
Mr. Hamilton spoke of the possibility of operating with single motor at about half normal speed. While some reduction in speed will likely be advantageous, from the viewpoint of maximum utility of the electrical equipment, I do not think that such a radical reduction in speed need be made. Perhaps 25 per cent reduction is more in line.

It should not be inferred that a reduction in hoisting speed with single motor is necessary when using a drive employing adjustable speed motors. This is merely an option which is likely to be most advantageous. It would be interesting to hear from operators as to what degree of importance they attach to the ability to operate at full speed on the rare occasions when only one motor may be in service.

Mr. Hamilton's point about using over-voltage in connection with a single motor is well taken. This practice need not necessarily be confined to the case where the two-motor armatures are connected in series. It could be employed, in some degree, when the motors are connected in parallel.

Mr. Burt pointed out the fact that it is difficult to compensate for IR drop by the simple expedient of over-compounding the generator. This statement may be quite true, I think, with reference to conventional adjustable-voltage control in which a wide speed range is obtained by voltage variation. In such a scheme the IR drop is considerable and its effect is important.

In the case of the new combination control, in which only a limited speed range is obtained by voltage variation, the IR drop and its effect are so greatly reduced that it becomes questionable whether over-compounding of the generator for purposes of compensation is justified at all. If compounding is employed, its amount is so small that any slight inaccuracy thereof is not of significant magnitude.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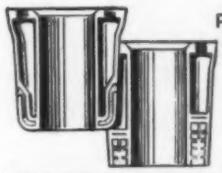
Special
TUYERES
Combat severe burning conditions


BUTLER-HENRY HEAVY NOSE • FALCON SHROUDED • HOLZWORTH SPLIT NOSE • BEATON LEDBETTER • FLEISCH SAFETY • KENNEY HEART SHAPED • STEINBACHER ANGLE-FLOW • BEATON REFRACTORY NOSE
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Established 1900 YOUNGSTOWN 3, OHIO Incorporated 1895

ROWAN
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THE ROWAN CONTROLLER CO., BALTIMORE, MD.

AN IMPROVED SYSTEM OF

Electric Drive for Cranes

. . . . describing a new system with characteristics resulting in superior hoist performance and applicable for either d-c or a-c incoming power . . . .

▲ A system of hoist drive recently developed has been applied successfully to several different types of crane, and there are two reasons for thinking that this system will be of interest to the iron and steel industry. A radical improvement of characteristics is provided for the hoist by which a superior combination of speed and safety is provided, which is important for its own sake. The hoist drive can be designed for operating from either d-c or a-c incoming power. It will be shown that this latter fact makes it possible to provide an advantageous performance of the entire crane when designed for operation from a-c power at the crane runway. The advantages of a-c power supply, where available and suitable for the application, are too obvious to require explanation.

Overhead traveling cranes have three common motions: the bridge travel, trolley travel and hoist. Some specialized cranes have other types of motions, particularly in the steel mills, but these special cranes are only a small percentage of the total; hence this discussion will be confined to the three common motions with special emphasis on the hoist.

A-C DRIVES FOR BRIDGE AND TROLLEY

The drives for the bridge and trolley are simple reversible motor applications with simple reversible control. For these motions, either d-c or a-c slip ring motors may be used successfully with perhaps a small advantage in favor of the a-c. Motor sizes for bridge and trolley drives are usually determined by the torque required to accelerate the bridge or trolley from standstill to full speed at a reasonable and safe rate of acceleration rather than by the torque required to propel at rated speed in feet per minute. Slippage of the track wheels should, of course, be avoided since it decreases the traction and the rates of acceleration and retardation which can actually be obtained. A further reason for avoiding slippage is to prevent excessive wear, and possibly flat spots, on the wheel treads and rails. Therefore the maximum torque of a bridge or trolley motor which is actually useful is somewhat less than that which will slip the wheels under typical conditions of traction. In some cranes the maximum useful torque may be considerably less than the wheel-slipping torque in order to prevent excessive swinging of the load if the controller is moved too rapidly. Accordingly the extreme overload torque which the d-c series motor is capable of delivering is not always useful and may be somewhat disadvantageous. For the same reasons the feeder voltage drop during the rapid acceleration or plugging of an a-c bridge or trolley motor is not ordinarily disadvantageous but tends to be somewhat advantageous. The decrease of torque of the a-c motor under such conditions helps to keep the motor from slipping the track wheels.

In the bridge and trolley motions, particularly if of up-to-date design equipped with roller bearings, the friction load at maximum speed is much less than rated load. Therefore, when the usual series d-c motors are used, the motor speeds are much higher than rated speed and high ratios of gear reduction are needed accordingly. It is difficult or impossible to predetermine accurately what the gear ratio should be because of the wide and unpredictable variations of free-running

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

by **J. A. JACKSON and M. A. WHITING**

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GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

frictions. For these reasons the free-running speeds of the bridge and trolley may be and often are much higher than the specified speeds. Since the kinetic energy of a moving body is proportional to the square of the speed, it can be seen that the crane is more difficult to control, particularly in stopping, when operating at these speeds which are variable and higher than intended.

One other advantage of a-c motors for bridge and trolley drives is that, for motors of equal size and speeds, the accelerating torque from standstill to rated crane speed can be maintained (within the limitation imposed by wheel slippage) at a higher average value on an a-c motor than on a d-c motor. Hence the a-c motored crane reaches rated speed sooner. Although a d-c motor can exert a higher maximum overload torque than an a-c motor, it is, for reasons mentioned, of no particular use on the bridge and trolley motions of a crane.

A-c motors may be "plugged" to retard or stop a bridge or trolley just as effectively as can a d-c series motor. However, it is now common practice to use hydraulic brakes for the bridge, in which case plugging is used only in an emergency.

To sum up: d-c motors for the bridge and trolley tend to be somewhat preferable for some cranes, and a-c for others. The margin of advantage, one way or the other, is slight or negligible. It may fairly be stated that either type of motor drive is suitable and the choice may properly be dictated by the type of power supply which is most conveniently available.

REQUIREMENTS FOR THE HOIST

Since a-c slip-ring motors are entirely suitable for the bridge and trolley motions, the problem involved in designing a high class crane for operation from a-c power at the crane runway consists in finding or developing a good hoist drive.

When the development was undertaken, a study was made of the characteristics, good and bad, of all known crane hoist drives. A specification was compiled, including a set of ideal speed-load curves, to cover an ideal crane hoist drive, regardless of power supply or the problem of meeting the specification. The most important items of this specification are stated subsequently. This was followed by a thorough study of all known means of driving a crane hoist. No existing system was found which would adequately meet all of the requirements but it was evident that the adjustable-voltage system offered the greatest promise. By this system the a-c incoming power could be made to do indirectly many things which it could not do directly. It appeared also that it should thus be possible to make the converted a-c power do a better job than can be done by a d-c series motor with dynamic braking. The logical next step was to undertake the development of an improved adjustable-voltage system having whatever radically new features might be necessary to meet or approximate the requirements of the ideal specification. The result of this campaign was the invention and development of the crane hoist system described in this paper.

THE IDEAL CHARACTERISTICS

A complete enumeration and explanation of the characteristics of an ideal crane hoist is somewhat

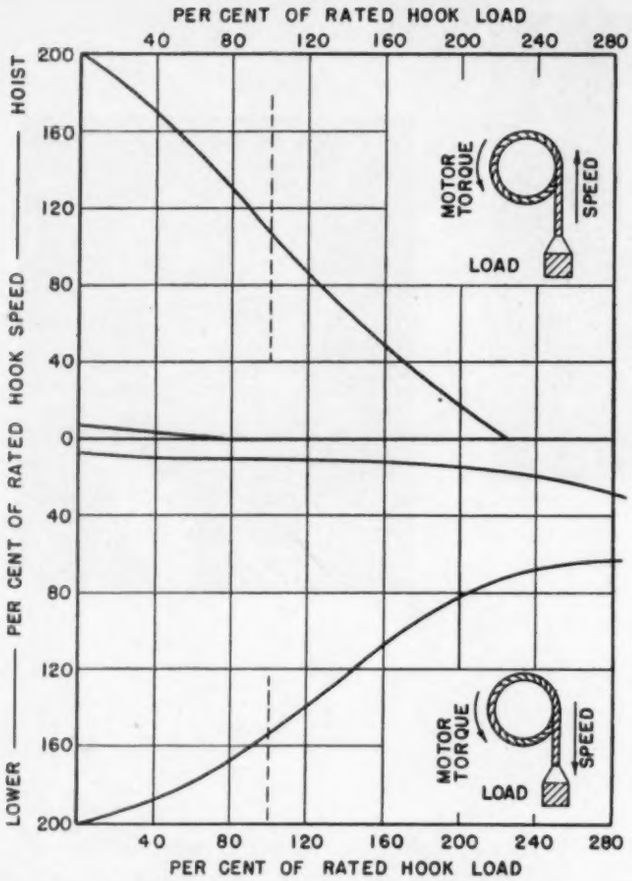
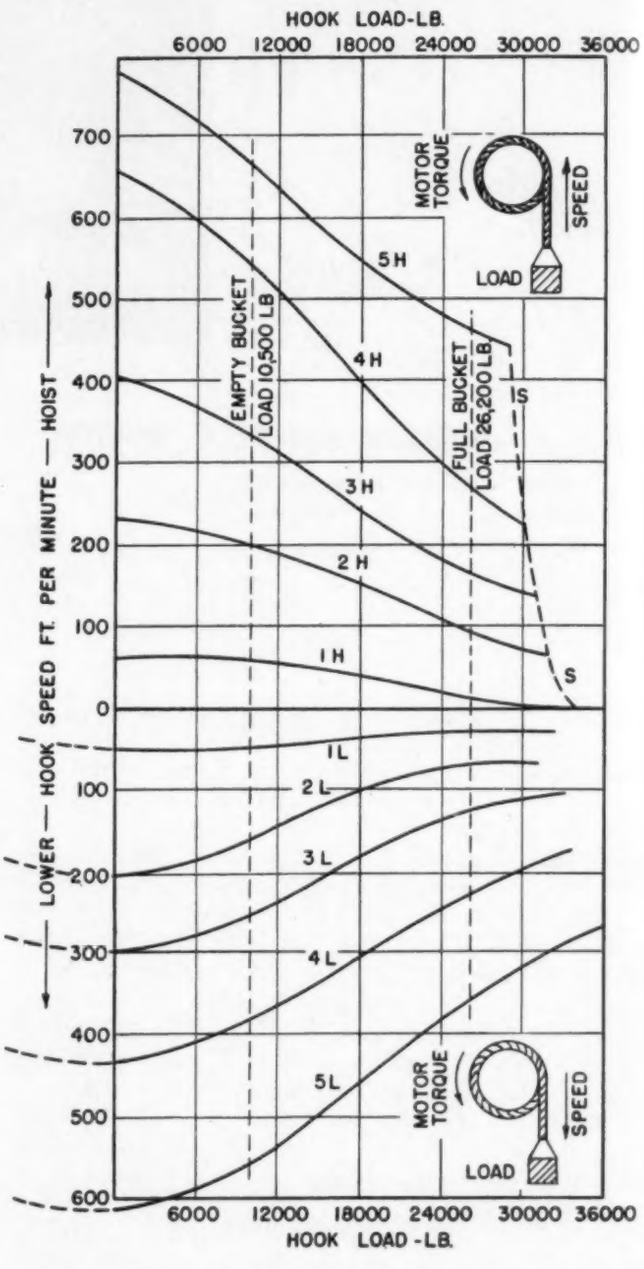

PER CENT OF RATED HOOK LOAD
40 80 120 160 200 240 280
LOWER — PER CENT OF RATED HOOK SPEED — HOIST
200 160 120 80 40 0 40 80 120 160 200
MOTOR TORQUE
SPEED
LOAD
MOTOR TORQUE
SPEED
LOAD
40 80 120 160 200 240 280
PER CENT OF RATED HOOK LOAD

Figure 1 — Characteristics of developmental sample of new system, as calculated from tests.

Figure 2 — Characteristics of hoist of cantilever gantry crane, from tests of installation at Fontana Dam.



lengthy. Therefore, the following short list enumerates only certain requirements of the ideal drive which are met only imperfectly or not at all by the usual types of drive.

1. The maximum hoisting speed with empty hook should be a definite value, approximately twice or perhaps two-and-one-quarter times the speed at rated load. In the present system using a d-c series motor, the speed of hoisting the empty hook may reach three times rated speed, which requires a reduction of the height above the floor at which the overhoist limit switch must be set. Thus the definite and moderate speed of the ideal system increases the available lift when handling loads.
2. At the full-speed hoisting position of the control the stalled torque should be self-limiting to a selected reasonable overload value.
3. The maximum speed of lowering the empty hook should be approximately as high as that of hoisting the empty hook but the maximum speed of lowering heavy loads should be substantially less than for the empty hook, and the greater the load the slower the lowering speed. This is certainly the most radical and probably the most important item in the characteristics of the ideal system.
4. The lowering speeds at the first lowering speed position should be low, and little, if any, greater at heavy loads than for the empty hook.
5. When handling the maximum load which can be lifted from the floor, the available torque capacity in the lowering direction must inherently be ample to maintain dependable control of the load under the most unfavorable conditions.
6. The adjustments should not be too difficult. The margin of safety and general superiority of characteristics should not be lost or seriously impaired if the adjustments differ moderately from those of the best choice.

To summarize, the ideal crane hoist system is one whose wide-open speed at each condition of loading is the maximum which is consistent with safety and ease of control. The system advocated by the authors approaches this ideal closely and has therefore appropriately been termed the "maxspeed system."

CHARACTERISTICS OF THE HOIST

Since this system has not yet been installed on any steel mill crane it is appropriate, before proceeding with this presentation, to show that the system is successful. After the system had been invented and preliminary calculations made, a 50 hp developmental sample was assembled and tested. The tests were made on the factory floor, using an artificial "live" load imposed by a d-c machine geared to the hoist motor. The loading system used provided a close simulation of an actual roped-up job. Figure 1 shows the characteristics calculated from the test data and expressed as equivalent load on the crane hook. Figure 1 reveals one interesting and important fact which would be difficult or impossible to demonstrate on a roped-up job. Because the live load was electrical instead of a weight hanging on a hook, it was possible to impose a lowering load greater than the maximum which could have been lifted off the floor in a crane installation. It is significant that, under this extreme condition of loading, the maximum lowering speed was less than rated speed and the lowering operation was thoroughly stable and under control.

A master mechanic or general superintendent might be justified in saying that an artificial live load imposed by an electrical arrangement is not altogether convincing. Figure 2 shows the characteristics of two duplicate equipments which have been operating continuously on a three-shift six-day week for more than a year. Because of the unusual operating requirements the characteristics of these equipments were proportioned differently in some respects from those of Figure 1. The characteristics of Figure 2 represent test weights on the hook — not values calculated from ampere readings as were the hook loads of Figure 1.

Each of these hoist equipments is of 187 hp continuous capacity, having a maximum speed of hoisting the empty hook of 775 fpm. Roped 2/1, the maximum rope speed is 1550 fpm. The installation consists of two cantilever gantry cranes operating on the top of the trestle shown in Figure 3. During most of the construction the duty consists of lowering loaded buckets of concrete to the forms and lifting the emptied buckets. Occasionally, however, these cranes do roustabout work. It is important that, if hitched to an excessively heavy lift when the rack (trolley) is at the outer end of its travel, the maximum torque of the hoist motor shall not be capable of overturning the crane. For this reason a feature was included in the control for limiting the maximum effort of the hoist motor to a value as shown by dotted curve S-S in Figure 2.

Another installation has been placed in operation more recently at the Shasta Dam, a Bureau of Reclamation project in the Sacramento River Valley. This crane is a gantry of special design. It was used in the installation of the sliding gates of the penstocks and certain other items of equipment, and will be retained permanently for general maintenance. This crane has a main hoist rated 125 tons at 5 fpm, using a 60 hp motor and an auxiliary hoist rated 25 tons at 18 fpm, using a 45 hp motor. The speed characteristics are similar to those of Figures 1 and 2.

Additional equipments of this type are under construction for operating the hoist and luff motions of eight whirley cranes.

Flexibility of adjustment is provided to a degree which has been found to be ample. For example, the ratio of fastest lowering speed to fastest hoisting speed is not fixed by the design but is adjustable on the job. The slowest no-load hoisting speed may be made adjustable independently of the slowest lowering speed, but to date this has been found unnecessary. It has been found that adjustments specified by the designers and made at the factory provide a suitable distribution of the speed characteristics at intermediate controller positions. However, these adjustments can be readily changed if desired.

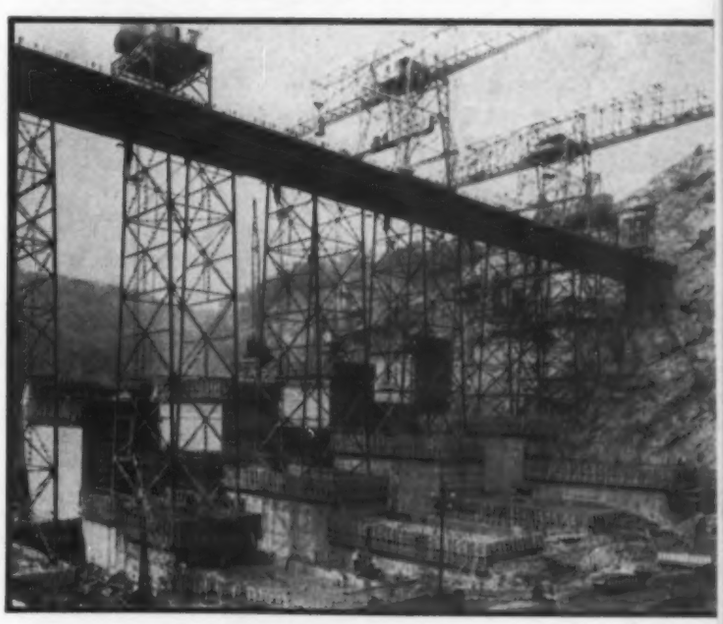
ELECTRICAL EQUIPMENT FOR THE HOIST

Except for its field coils, the hoist motor is a duplicate of the motor which would be used in the standard d-c crane. Except for its operating coil, the hoist brake is a duplicate of the brake which would ordinarily be used.

On the crane bridge a motor-generator is mounted. For an a-c installation this set consists of a squirrel-cage induction motor, a generator of normal design, an ordinary constant-voltage exciter and a special "cross-flux" exciter. For an installation having d-c incoming power, a shunt-wound d-c motor will be substituted for the induction motor and the constant-voltage exciter may be omitted.

The cross-flux exciter, although of a novel design and somewhat unusual construction, is a very sturdy machine, both electrically and mechanically. Its commutation is excellent and experience to date indicates that this machine does not introduce any unusual maintenance requirements. Since the cross-flux exciter armature supplies only field current for the main machines, it is itself a small machine. The basic parts of

Figure 3 — General view of Fontana Dam construction. A standard whirley crane at the left of upper trestle. Two cantilever gantries at right.



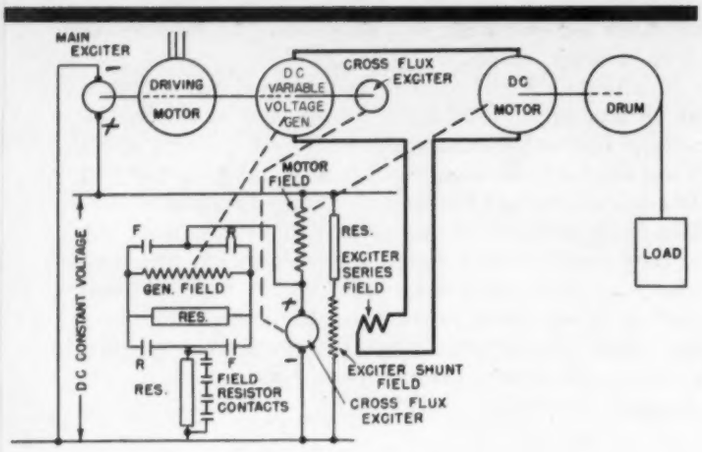


Figure 4 — Elementary scheme of connections of improved system

which it is built correspond in size to those of an ordinary exciter whose capacity is from 5 to 7 per cent of the hoist motor capacity.

Although this exciter uses a cross-flux principle, it is not an amplidyne but is very different from the amplidyne in almost all respects. The amplidyne requires the use of armature reaction as a means of excitation. To obtain the necessary armature reaction a short-circuit is applied to the amplidyne armature by a set of brushes midway between the main output brushes. The cross-flux exciter of the "maxspeed" system has only two brush-holder studs, its armature has no short-circuited path and the armature reaction is not utilized in the provision of the advantageous characteristics.

On the crane bridge or in the cab is a control panel consisting principally of small contactors and small resistors for handling the generator field current and brake coil current.

Figure 4 shows, in elementary form, the electric circuits and the mechanical arrangement. Ordinarily five trolley rails are required for the hoist, only two of which must handle main current.

The unusual and advantageous characteristics of the system are provided principally by the unusual characteristics of the cross-flux exciter and by the system of connections between this exciter and the other items of the equipment. The construction of this exciter and its theory of operation are explained in the paper "A New Electric Hoist Drive For Cranes" by M. A. Whiting, published in "Electrical Engineering," February 1944. Therefore only a brief discussion of the design of the equipment is presented in the following.

Figure 5 shows the output characteristics of a cross-flux exciter of typical design. It is of interest to note that, for either direction of hoist motor current, the voltage of the cross-flux exciter decreases with increase of hoist motor current. Two uses are made of this characteristic of the exciter voltage. These two uses are indicated in Figure 5 by the showing of the generator field and motor field connections superposed upon the plot of the cross-flux exciter characteristic and main exciter voltage. Figure 6 is a simplified diagram of connections which illustrates the same relation.

As evident from the foregoing illustrations, the cross-flux exciter voltage is used as the source of generator excitation. The voltage of the cross-flux exciter is maintained non-reversible. The reversal of direction of the hoist motion is accomplished by a typical reversing control with field resistor steps interposed between the cross-flux exciter armature and the generator field. Thus the generator voltage at any one operating position of the controller is greatest at zero current and decreases with increase of load current.

As mentioned, another important use which is made of the cross-flux exciter voltage is that it varies the hoist motor field in an advantageous manner. The cross-flux exciter is designed and adjusted for a maximum voltage of approximately 60 per cent of the constant main excitation voltage. The two sources of excitation are connected, as shown in Figures 5 and 6, so that their difference is available for exciting the hoist motor field. Thus the motor field is weakest when its armature current is very low or zero, and becomes greater at increased motor armature currents. This scheme of motor excitation provides several advantages:

1. When lowering a heavy load at any controller position the motor field is strong — the heavier the load the stronger the field. This prevents instability of speed.
2. In the lowering of a heavy load at any controller position, when a fast retardation begins, the motor field is already strong but the increase of current for the retardation causes a further increase of motor field strength. This field strength continues high at the "off" position as long as the retardation current continues high.
3. When continuing to stand at the "off" position the motor field current is reduced, thus avoiding excessive heating.
4. The maximum speed at empty hook is moderately greater than could be obtained by the use of the same generator voltage if the motor field were maintained constant at normal value throughout.

COMPARISON WITH STANDARD HOIST EQUIPMENT

Some of the benefits of the system are illustrated by a comparison of its speed characteristics with those of the standard d-c crane hoist system. It is well-known that in many d-c cranes the full-speed lowering characteristic must be an undesirable compromise between conflicting requirements. The desired high speed of lowering the empty hook is in conflict with the necessity of providing safe maximum speeds when lowering rated load and overloads. The problems involved and the necessity of adopting a compromise between these two conflicting requirements are fully explained in a paper by J. A. Jackson published in the 1938 A. I. S. E. Yearbook, page 538. The opinion of most well-informed and responsible persons seems to be that a no-load lowering speed 150 per cent of rated speed is about the fastest which can be provided without incurring serious risks when lowering heavy loads. This is true for modern commutating pole mill motors. But for motors without commutating poles the limitation to safe maximum speeds when lowering heavy loads requires that the maximum speed of lowering the empty hook be limited to considerately less than 150 per cent of rated speed.

Figure 7 shows a comparison of the characteristics of the two systems. The fastest and slowest characteristics for the standard system are drawn in broken lines. The characteristics shown are averages based on a study of several different sizes of motor. The fastest lowering characteristics for some installations will be somewhat less steep and dangerous than shown but for some other installations may be even steeper and more dangerous. The corresponding characteristics shown for the "maxspeed" system are drawn in solid lines in Figure 6 and are those of the preliminary sample equipment, replotted from Figure 1.

In the "maxspeed" system a substantial increase of lowering speed at empty hook and partial loads has been provided without any hazard when lowering rated loads at the full-speed controller position. Even more conspicuous is the contrast between the two systems when lowering heavy overloads. In the standard system when heavy overloads are lowered at the full-speed controller position the armature reaction becomes so great and the speed becomes so high as to approach closely or in some cases reach a hazardous condition; in fact runaways have occurred and armatures have been wrecked under this condition. In the "maxspeed" system when lowering a heavy overload the motor field is stronger than normal and the speed is considerably less than at normal load. In the equipments shown in Figure 6 when lowering 25 per cent overload the maximum speed of the new system is only 75 per cent of that of the standard system, accordingly its kinetic energy is only 56 per cent. When lowering 50 per cent overload the new system can attain only a little more than rated speed and has the benefit of a strong motor field but the standard system is in danger of running away.

Another important contrast is shown by a comparison of the first lowering speed characteristic in Figure 6. The speed of the standard system varies rather widely over the range of loads but in the new system the speeds are nearly alike at all loads and much slower at all except the very smallest loads. Jogging of loads is accordingly much easier and under better control in the latter system.

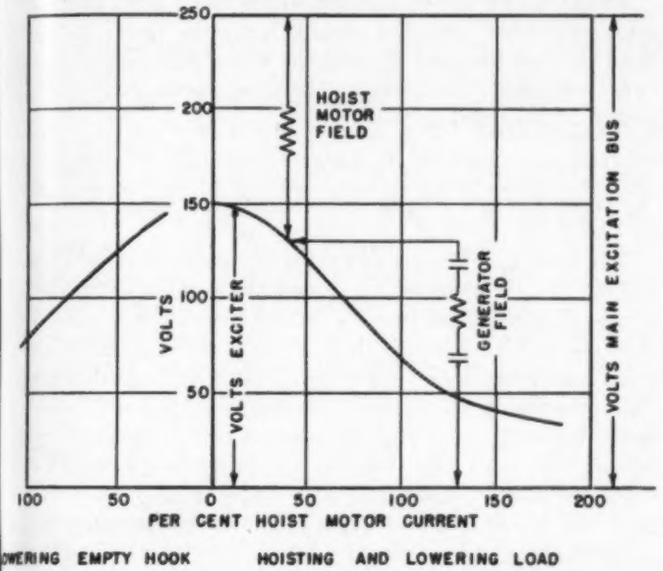
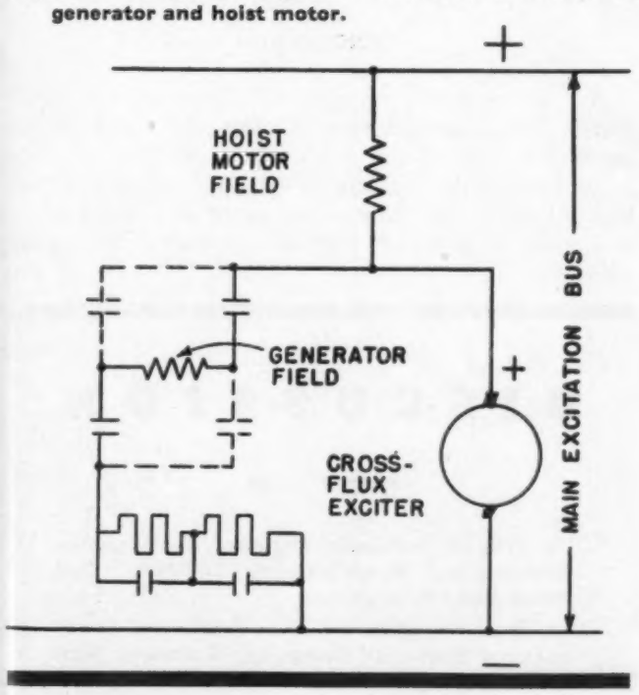


Figure 5 — Characteristics of a typical cross-flux exciter. Also shown is the relation of generator excitation and hoist motor excitation to the voltages of the main and cross-flux exciters.

▲

Figure 6 — Simplified diagram of connections of fields of generator and hoist motor.



TRANSIENT CHARACTERISTICS

The same means by which the superior speed-load curves were obtained provided excellent transient characteristics also. When lowering at full speed at any load, from empty hook to maximum overload, if the controller is moved abruptly to the "off" position the peak currents are not excessive. It has been found that the peak currents when thus stopping various descending loads, including maximum overload, are nearly alike and not much greater than for stopping the empty hook. If the hoist is plugged hard when lowering any load, the peak current is no greater than when stopping the same load by a quick movement to the "off" position. Offhand, these characteristics may be astonishing. However, they were predicted, based on theoretical considerations, before the system was tested. The explanation is not very obscure but is somewhat lengthy and is therefore not included here.

CONTROL OF BRAKE SETTING

It is generally recognized that, if the brake sets immediately whenever the controller is moved to the "off" position, the frequent setting of the brake at high speed causes excessive heating and wear of the brake wheel and shoes. Consequently, in the usual steel mill crane hoist provision is made whereby the setting of the brake is delayed automatically until the motor has performed the major part of the retardation.

In the "maxspeed" system the desired delay is provided by a relay whose operating coil is directly in series with the generator field. During a retardation at the

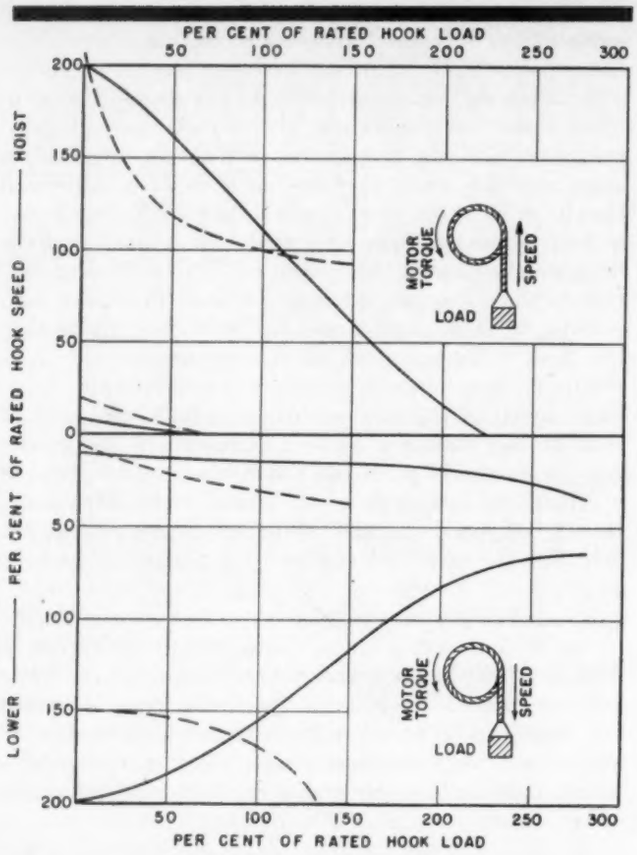

PER CENT OF RATED HOOK LOAD
50 100 150 200 250 300
LOWER —— PER CENT OF RATED HOOK SPEED —— HOIST
200 150 100 50 0 50 100 150 200
MOTOR TORQUE
SPEED
LOAD
MOTOR TORQUE
SPEED
LOAD
50 100 150 200 250 300
PER CENT OF RATED HOOK LOAD

Figure 7 — Characteristics of the improved system compared with those of the standard system. The new system is in solid lines, the standard system in broken lines.

"off" position of the controller this relay prevents the brake from setting until the generator field current has declined to a very low value, by which time the hoist speed has been greatly reduced. This arrangement provides a good approximation to the ideal requirements. When the controller is moved away from the "off" position the release of the brake is not influenced by this relay, hence does not wait upon the building up of the generator field. When a load is jogged or moved steadily down at the first lowering position of the controller, the generator field current does not rise sufficiently to pick up this relay, hence the brake setting is not delayed. Regardless of how low the drop-out of this relay is adjusted, the generator field current is sure to reach zero at the "off" position, hence the brake cannot fail to set.

The brake setting time is easily adjustable for less delay (or even no delay) if desired.

EMERGENCY PROTECTION

In an emergency, such as failure of incoming power or overspeed of the motor-generator or when the hand-operated emergency switch is tripped, a quick-acting spring-closed contactor connects a braking resistor across the motor armature, opens the feed to the generator field and causes a brake application immediately. On the preliminary sample and on the installations, many power failures have been created purposely under all conditions of load. The emergency retardations are prompt but not particularly rough, either electrically or mechanically. In fact, the emergency retardations are practically as smooth as the fastest normal retardations of equal loads on the hook.

When the emergency protective feature operates, the loop circuit between the hoist motor and generator armatures is not opened. As far as the emergency stop in itself is concerned, there is no particular advantage or disadvantage in thus keeping the loop circuit closed. The advantage lies in the fact that, since the loop circuit is never opened, there is no risk that misoperation or a defective condition of a contactor can keep the loop circuit open when it is supposed to be closed.

In the many power failures which have been caused purposely while lowering various loads the speed of the hoist did not increase beyond the speed at which it has been running. The motor-generator speed rose only about 10 per cent.

OPERATION FROM D-C INCOMING POWER

The most obvious prospects for the application of this system are those in which the power service naturally available is a-c. However, cases probably exist in which only d-c service is available but the performance of the hoist leaves much to be desired. Under such conditions it is reasonable to consider the adoption of the "max-speed" system, retaining the present bridge and trolley equipments and the present d-c power supply. The motor-generator will be d-c/d-c and the cross-flux exciter will be of normal design. The main exciter may be omitted and the incoming d-c circuit used as the source of constant-voltage excitation. In such a change-over the hoist gearing need not be changed. By merely a change in motor field coils and brake coil the original motor and brake may be retained. One additional collector of small capacity must be installed.

CONCLUSION

The development here described provides two benefits. A hoist performance is obtained which is far superior to that of any previous system. This superior hoist performance makes it possible to obtain the highest quality of crane performance as a whole when the crane is supplied with a-c power at the crane runway.

DISCUSSION

PRESENTED BY

C. B. RISLER, Industrial Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

J. H. MILLER, Electrical Superintendent, International Harvester Company, Wisconsin Steel Works, Chicago, Illinois

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

J. A. JACKSON, Engineer, Machinery Manufacturers Section, Industrial Engineering Division, General Electric Company, Schenectady, New York

C. B. Risler: Within the last decade the development of adjustable voltage drives — particularly those with supplementary rotating regulators and exciters — has progressed at a rapidly accelerating rate. The complete list of accomplishments along this line has by no means been realized. Special modifications of the familiar Ward-Leonard drive have been made for use on blast furnace skip hoists, shovels, mine hoists, construction cranes and most recently on heavy duty cranes in Navy Yard service for the building and rehabilitation of ships.

Variable voltage drives with the characteristics presented have a well founded use in the special hoist field where high light hook speeds, automatic regulation of the speed at which loads of various weights can be handled, and the relief of responsibility from the operator can justify the additional complexities of generators, exciters, multiply field machines and associated cost. However I would like to emphasize that the d-c rheostatic crane hoist drive is far from obsolete and will meet the requirements of many special duty cranes. Furthermore, rapid developments in the field of a-c crane hoist equipment are making further inroads into the industrial crane field that used to be handled exclusively by direct current.

The ability to obtain high light hook speeds with a drive of this nature is an accomplishment which must be handled with caution. We do not want to become excessively speed conscious or involved in a speed contest to a point where the crane is faster than the capacity of the handlers and operators to keep it loaded and in operation. In other words, I see little use for a hook to be lowered at 200 per cent speed and then have to wait for three minutes for the slings to be applied to the equipment to be lifted.

The authors mention light hook hoisting speeds as high as 225 per cent. A statement of the maximum speed range and the limiting factor would be of interest.

Since power lowering of a non-overhauling light hook is frequently required in hoist service, I believe it would be of interest to all to see a complete set of the lowering curves in the third quadrant. I think they will be approximately a mirror image of those in the fourth quadrant.

The authors indicate in Figure 2 that the maximum torque is limited to lift approximately 34,000 pounds. This characteristic is shown in the dotted line. I would like to inquire if this is an inherent characteristic or requires the use of a load relay of some type.

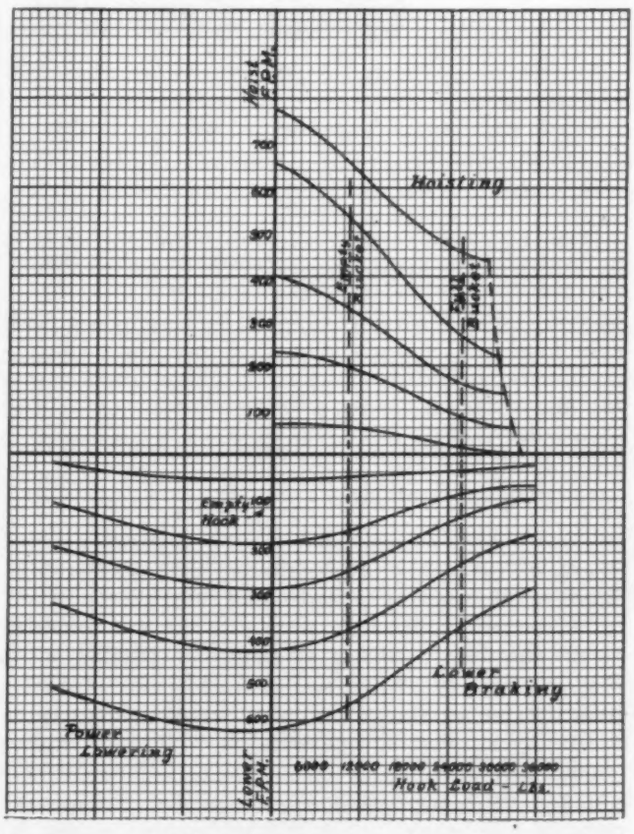
J. H. Miller: On what size or type of crane is the d-c/d-c generator recommended, and what consideration has been given the additional weight on the crane?

L. R. Milburn: I would like to ask Mr. Jackson where in the steel industry, where practically all cranes have d-c constant voltage, we would be justified in installing adjustable voltage on a hoist. It is true that there are great possibilities in all steel mills of limiting the load capacity or the ability of a crane to pick up a load that is within its capacity. We all know that a crane on a runway has a theoretical capacity, and yet anything that is on the floor that needs to be picked up is generally handled by that crane.

J. A. Jackson: First with regard to d-c dynamic braking, I don't think any of us are advocating any general changeover of d-c cranes in steel mills to this new system. Such a general change would be difficult to justify economically. Where building extension is contemplated and a-c is available, particularly if d-c conversion equipment is already loaded up, the proposed drive has an appeal both economically and from an operating viewpoint. That perhaps is its largest field in steel mills. However, its characteristics are much superior to those supplied by dynamic braking for roll changing cranes, machine shop cranes, ladle cranes and other cranes doing refined and dangerous work, and on old cranes with worn out control, a change to the new system would be in order using d-c/d-c motor generator sets.

The stalled feature to prevent handling excessive overloads is worthy of consideration where undisciplined operators wreck armatures by careless lowering of such loads after having picked them up on a crane using the d-c dynamic braking system. Such wrecks are not unusual. To take care of emergency work, it is entirely feasible to increase the stalled load setting by a simple

Figure 8 — Showing speed load curves in the power lowering quadrant.



(*Please turn to page 84*)

Low Temperature Welding IN STEEL PLANT Maintenance

. . . . by proper choice of welding alloys for the material to be joined, welds can be made at temperatures materially lower than normal . . . . the characteristics of these low temperature welds and the ease of their application open a wide field of use in plant maintenance . . . .

by R. D. WASSERMAN, PRESIDENT
EUTETIC WELDING ALLOYS COMPANY
NEW YORK, NEW YORK

▲ SINCE Pearl Harbor considerable study has been given to studying the innumerable new applications that have been added to the many already known in the maintenance welding field. Steel mills have not only been quite a bit ahead of other industries in maintenance welding, but the average steel mill actually does more maintenance work. Therefore, they have been extremely interested in the latest development of maintenance processes — that is in "low temperature" welding.

"Low temperature" welding, originally developed in Switzerland, was introduced in this country three years ago, and since then research has further advanced it and extended its application to new fields. I will try to explain the meaning of "low temperature" welding and how it was developed, by comparing it to similar processes with which we are more familiar, such as soldering and brazing.

Soft-soldering, as you may know, uses alloys applied below 750 F which simply adhere to the surface of the parent metal. They may be used on ferrous and nonferrous metals. Soft solders are predominantly combinations of lead and tin in varying proportions, although for certain applications small additions of antimony, cadmium or silver may be added to obtain particular properties.

When preparing to solder, the parts to be joined must be thoroughly cleaned and degreased and then fluxed. The heat for soft soldering may be applied by a soldering iron (which is actually copper), by dipping the parts to be joined in molten solder, or by sweating, which is usually accomplished by means of a blow torch, acetylene and air torch, or oxy-acetylene torch. Soft solders are usually used for sealing lap joints or lock seam joints where the solder itself is not intended to develop particularly great strength.

Brazing has been defined as the joining, without fusion, of various metals in similar or dissimilar combinations by means of a nonferrous alloy filler material. In other words, brazing is similar to soft-soldering except that the temperature range for brazing starts at approximately 1200 F, and goes up to approximately 2000 F. The bonding action of a brazed joint is again essentially a sweating operation in which the molten brazing alloy flows between lapped or butted surfaces which have been heated slightly above the melting point of the brazing alloy. When brazing, almost all joints are lap joints, as the brazing alloys are not de-

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

signed to have much strength in themselves. In fact, the clearances between the parts must be held within fairly narrow limits if the maximum strength of the joint is to be obtained. It has been shown that the maximum strength of brazed joints is generally obtained with a clearance of approximately .0015 in. with the strength rapidly falling off to a fraction of the maximum value when the clearance exceeds .020 in.

Preparations for brazing are quite similar to those for soldering, in that the parts must be cleaned and degreased, then fluxed and assembled. The temperature at which brazing is done is so high that the use of irons to apply heat is no longer practical, so the heat is generally applied by some type of torch, in an oven or by high frequency induction equipment.

There are, in general, two types of brazing. The most commonly used is the high-melting brass type brazing alloys, and the second type is the lower melting silver solders or silver brazing alloys. The brass type alloys have melting points between 1600-1800 F, and are generally made of copper and zinc. Another type of brazing which requires still higher temperatures is copper brazing, which is done in controlled atmosphere furnaces.

Bronze welding is a variation of the use of brazing alloys in beveled butt joints or as the filler metal for fillet welds. The strength of such joints is determined by the quality of the bond of the brazing alloy to the base metal, and by the strength of the brazing alloy itself.

Silver soldering is performed very similarly to brazing with brass alloys, except that the temperatures required are generally lower, ranging from 1200-1600 F. In general, silver solders are alloys composed of various proportions of silver, copper and zinc. They are applied as described before and will develop sufficient strength only if the proper clearances and amount of overlap are used. Silver solder should not be used for square-butted joints where high strength is required unless clearances can be accurately controlled to less than .003 in.

Different from soldering and brazing which have just been briefly reviewed, "low temperature" welding makes full use of a phenomenon of surface-alloying which in the past has been practically ignored. For "low temperature" welding, alloys have been developed for each application on each of the commonly used metals.

Studies were made to determine the affinity of various metals for each other. Then filler rods were created which, besides containing largely the components of the metal or alloy they were designed to weld, also contained those metals which had a particularly strong affinity for the metals in the parts being joined. In short, eutectic alloy films are formed on the surface of the base metal where the weld metal and the base metal are in contact without melting the base metal. In many cases, the base metal may be 400-1000 degrees below its melting point when it is joined to the weld metal. A liquid alloy is formed on the parent metal at a temperature preindicated by the melting of a special flux designed for each welding rod. This surface alloy is the eutectic alloy of those metals present at the point of union of the weld metal with the parent metal. The flux has acted very much in the manner of a catalyst, reducing surface tension, preventing oxidation, and aiding in alloying.

As you know, eutectic is a metallurgical term which refers to the lowest-melting alloy of the series of alloys which may be made from any given group of metals. The "low temperature" welding rods are not all eutectic alloys, but the reaction occurring between the weld material and the base metal during the operation pro-

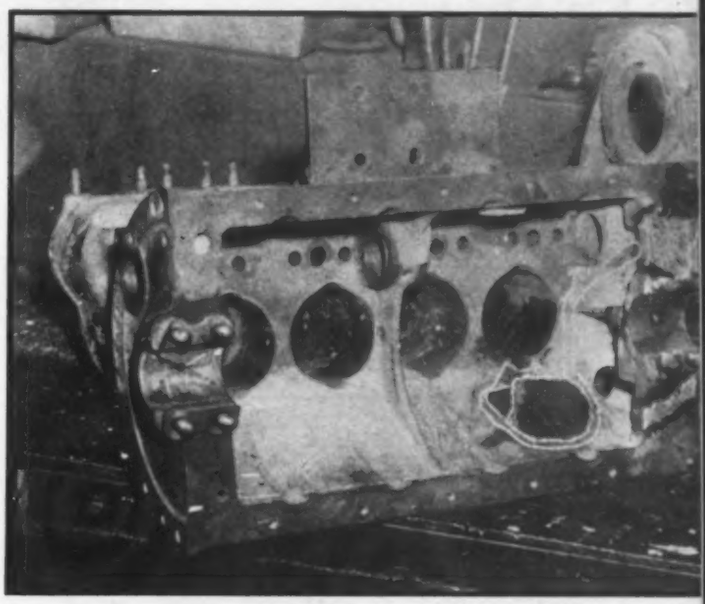


Figure 1 — Cast iron motor block oxy-acetylene welded at low temperature with high-strength copper alloy.

duces a eutectic alloy on the surface of the base metal. Because of this alloying effect, this process is definitely "welding," although the alloys may be applied far below the fusion temperature of the base metals.

The process is well illustrated by a simple experiment. A sheet of copper is coated with the appropriate flux of one of the new aluminum "low temperature" welding rods. The copper plate is heated and when the melting flux indicates that the flow point of the rod is reached, the end of the rod is pushed straight down onto the copper plate. If the copper plate is held at this temperature for just a few seconds, the aluminum alloy rod will make a sharp hole right through the still solid copper This hole is the result of the eutectic alloy of copper and aluminum being formed which has a melting point some 700 degrees below the melting point of copper. This alloy being completely molten at this temperature has allowed the aluminum rod to be passed through the copper at that point. In other words, the solid copper at 1100-1200 F has dissolved in, or gone into solution with, the molten aluminum at the same temperature. It is this "dissolving" of the surface of the solid base metal in the molten weld metal that provides the high strength bond between them and makes the joint a real weld. Such dissimilar metals are not commonly used together, but the principle is the same when a molten "low temperature" cast iron welding alloy is applied to an iron casting which has a surface temperature not over 1400 F in the weld area.

These new kind welding rods can be classified in two groups. There is the "thin-flowing" group, which first

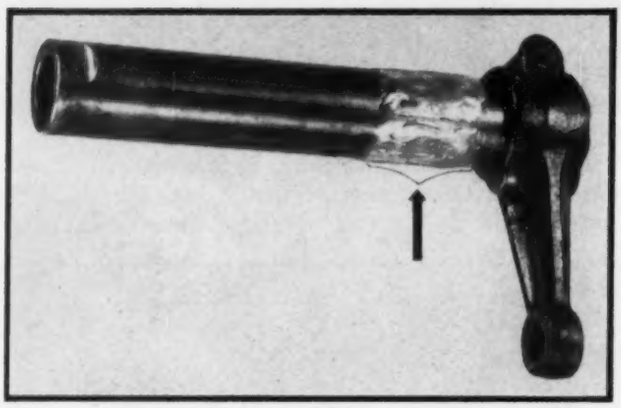
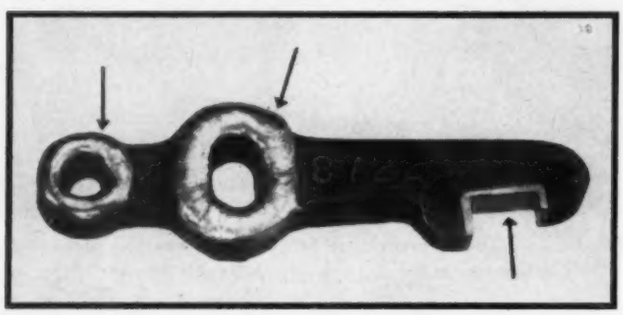


Figure 2 — A high-strength hard copper alloy is used here to overlay a worn steel shaft. It is applied at base metal temperatures of 1000-1200 F.

▲

Figure 3 — This cast iron bracket is overlaid on all wearing surfaces with a high-strength hard copper which reconditions it for longer than its original life.



flows through capillary action, and then alloys itself with the surface of the parent metal. This type is used mostly for joining sheet, tubings, and shapes. The second group is the "bead-forming" type, which is applied similarly to fusion welding and is used generally for welding of castings, metals of poor conductivity and for parts which cannot be heated broadly.

The "thin-flowing" type is used for butt and lap joints without a chamfer. Tensile strengths as high as 140,000-160,000 psi can be obtained with a clearance of .002 in. It is important to remember, however, that with a larger clearance of .030 in. the tensile strength is still as high as 80,000-90,000 psi. The "bead-forming" type gives very satisfactory tensile strength values on steel as high as 75,000 psi in a 90 degree "V."

"Low-temperature" welding is generally done with the oxy-acetylene flame. The "thin-flowing" types, which usually have a lower-melting point, can be applied with gas flames, in furnaces, or with induction heating. The "bead-forming" type, and in general, all the "low temperature" alloys melting above 1200 F, can be applied with atomic hydrogen or with the carbon arc, which would be advantageous when the heated area must be reduced to a minimum. There are eight types available for metallic arc applications for welding cast iron, malleable iron, alloy steel, bronze, copper, aluminum and hard overlays.

The welding technique is quite similar to brazing and bronze welding. The parts must be cleaned, coated with flux, and then heated. The alloy is applied without fusion of the parent metal, but here the similarity ends. The temperatures are, on the average, lower than those of brazing and the affinity of the alloys for the parent metal is greater, resulting in a joint that is metallurgically a real weld.

The advantages of such a process in steel mill maintenance are extremely important, and I will mention them in their order of importance.

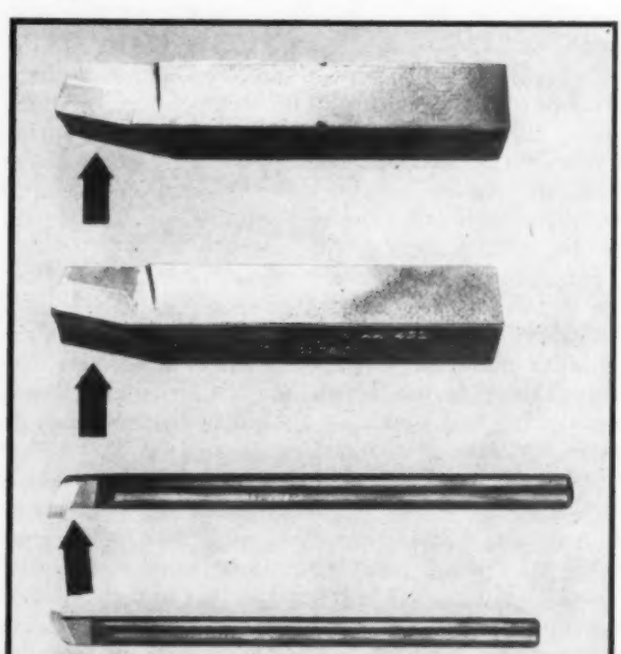
First, this process minimizes distortion, and original sizes and dimensions are easier to maintain. This is due to the small amounts of heat used with this process. By selecting the proper alloy from the 46 offered, it is possible in most instances to save expensive remachining, necessary if warping occurs.

Second, the amount of preheating and the time to preheat are reduced. This can be appreciated when it is realized that welding heat applied locally automatically reduces the amount of general preheating required when welding complicated structures, parts in locked-in areas, or parts where expansion is not possible. "Low temperature" welding does not completely eliminate preheating for such jobs, but the amount of preheating required will be cut in half and even less.

On a cast iron job, for instance, a preheat to 900 F is sufficient, whereas the cast iron would otherwise have to be preheated to 1400-1600 F. Many jobs that previously could not be accomplished without preheating can now be done without any preheating at all. It should be remembered that lower stresses are created because of the small amount of preheating used.

Third, not only have the joints made with "low temperature" welding alloys great strength, but what is more important, the parent metal (cast iron, high-carbon steel, etc.), is not heated to critical temperatures which might cause brittleness or segregations. Thus, the physical properties of the parent metal near the weld remain unchanged. Another important factor

Figure 4 — Tips are attached to tools with thin-flowing alloys.



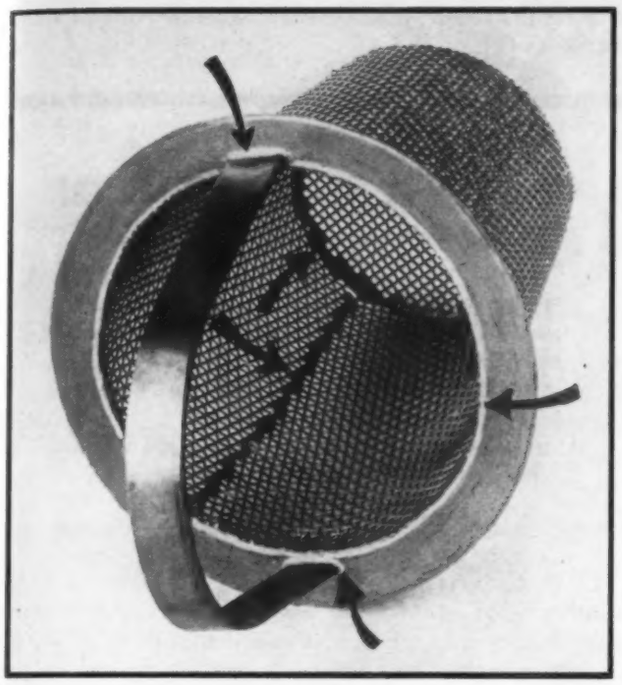


Figure 5 — A low-melting copper alloy was used to fabricate bronze strap and wire screen into this pickling basket.

is that hardening of the parent metal can be avoided by the use of the proper rod. In this way, machining (when required) is not difficult. This last advantage is extremely important when welding large structures or castings, where machinability of the weld is a major requirement.

To be more specific, I should like to mention briefly, some of the outstanding applications of the "low temperature" welding process. For use on cast iron parts, several alloys are offered. Particularly important, is the "low temperature" electrode which can be applied without preheating and without fusion of the cast iron. It is used extensively for cracked or broken castings.

For heavy castings requiring thick deposits of weld metal, two cast iron alloys are available. One is used as a gas welding rod and one is designed for arc welding, and both can be applied with very little preheating. The ferrous weld metal is entirely machinable, and has the same properties as cast iron.

For overlaying, a new copper-base alloy is used which can be applied at base metal temperatures of only 1200 F. This alloy can develop hardnesses approximately three times greater than bronze welding alloys. It has excellent corrosion resisting properties, and is very useful for overlaying worn drums, broken gears, valve seats, bearings, etc.

For castings which are slightly under-cut or defectively machined, and for repairing cracks in water jackets, etc., one newly developed alloy has been very successfully used. It requires a temperature of 345-600 F, and although the alloy is made of white metals, it adheres very strongly to cast iron and withstands pressure. Recently a large bearing housing which was under-sized .002 in. was completely overlayed and then remachined without the least bit of distortion. This welding application saved a considerable sum of money.

On steel, "low temperature" welding offers many advantages. One copper alloy can be used to join pipes and fittings made out of steel, malleable iron or bronze, and to join copper to steel. This alloy has a tensile strength in square-butt joints of 117,000 psi, is sufficiently free-flowing to be used in making lap joints, and can also be used for fillet welds. It can be applied much more quickly than fusion welding, oxy-acetylene welding, or arc welding, and the weld is leak-proof and superior in tensile strength.

For worn and defective rolls a "low temperature" electrode used for iron castings is offered. Applied without preheating, the weld remains perfectly machinable. Its hardness can be increased by peening to match alloy steel.

Worn valves, bearings, rods and shafts, can be overlayed with a nonferrous copper-base alloy between 1000-1200 F. This alloy can be work-hardened to 290 Brinell. This is quite remarkable when it is realized that the temperature of application is very low.

Another class of ferrous alloys having low melting points has been developed with hardnesses between 450-600 Brinell. These alloys are excellent for use on parts that have to withstand abrasive wear. One type is available for general use, another type for manganese steel, one group for tools and dies, and one group for use where corrosion resistance properties combined with hardness are required.

Bronzes and copper alloys can be salvaged very easily by "low temperature" welding. Heavy copper castings can be slightly preheated, and then carbon arc welded with a specially alloyed copper rod, resulting in a very sound weld.

Copper connections in electric motors can be repaired with a special alloy requiring about 1280 F, which can be applied with or without flux. If the job cannot be done with a torch, a special coated copper electrode is used which avoids dissipation of heat.

Electric motor shafts which are worn out can be overlayed with a nonferrous metal, requiring a temperature of 1000-1200 F. The hardness of this alloy can be brought up to 235 Brinell, and is 180 as welded. Here too, the dissipation of heat can be avoided by proper precautions.

Bronze guides, bearings, and rolls can be salvaged with the alloys designed for overlays having a hardness of 170-290 Brinell and applied at very low temperatures — approximately 400 degrees below those required for bronze welding — yet developing hardnesses twice as high.

Aluminum welding is known to be difficult for welders not familiar with this metal. The smaller amount of heat required in "low temperature" welding simplifies the welding of aluminum, so that the work can be done by less experienced welders. One alloy is available for aluminum castings, and another is specially adapted for sheet aluminum. The alloy for use on castings is available in coated electrodes and can be used with direct current.

There is much more that could be said about this new development. New uses are found every day. Because of the ease of application and the unequalled properties of these welds made at low temperatures, many maintenance engineers find that enormous savings can be realized. Undoubtedly, after the war, because of these

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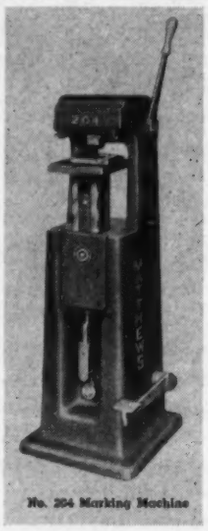
No. 204 Marking Machine

Roller Die with Interchangeable Type

Round Die for Marking Flat Parts

JAS. H. MATTHEWS & CO.
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Branch Plants
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Specialists for over a generation in
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ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

new results, more maintenance welding will be done than ever before.

DISCUSSION

PRESENTED BY

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

J. A. ROSA, Metallurgical Department, Republic Steel Corporation, Massillon, Ohio

R. D. WASSERMAN, President, Eutectic Welding Alloys, Inc., New York, New York

L. F. Coffin: There is no doubt but that we have another tool added for the use of steel mill maintenance men. I have only one question and that is whether the author can give us a little information regarding the ductility and resistance to fatigue, inasmuch as he mentioned increasing hardness by peening and mentioned hardness of 62 to 64 Rockwell C.

This tool, of course, has limited uses, as do all tools we have for steel mill maintenance. There is a challenge to steel mill maintenance departments to so modernize their maintenance equipment that, as our postwar problems are upon us, we may make use of all of these tools, each in its respective proper application.

While these are all well-known to you, I list just a few that we have that should be in common use in their proper place in a steel mill maintenance shop: brazing, welding, sprayed metal (spraying has many applications which in their proper place are invaluable), hard surfacing, flame hardening (that is a tool that should be used more in steel mill maintenance shops but with discretion), chrome plating, proper methods of bonding babbitt to castings (probably one of the most important tools that we can use), proper stress relieving equipment, sand or grit-blasting, proper heat treating equipment (used to the end of utilizing steels produced in your own plant where possible), dynamic balancing, and now low temperature welding.

J. A. Rosa: Mr. Wasserman has done a fine job of explaining the eutectic alloys, so I will not go into that. I have a question or two that I would like to ask, relative to hardness obtained from these alloys and also regarding their abrasion resistance. I am thinking now in terms of building up shafts which have worn out from abrasion and which probably will wear out again. How does the abrasion resistance of eutectic alloys compare to the parent metal?

R. D. Wasserman: One of the things which is so important in welding is true in our process, too. It is the procedure and the proper selection of jobs. Unless you have a good understanding of procedure and put enough care on it, you are naturally liable to end up with bad results on anything you start.

We think that any maintenance engineer who is in doubt should always try to get help from the supplier

(*Please turn to page 84*)

Additives in Oil FOR THE Steel Plant

. . . . additives impart to an oil specific properties which are lacking in the conventionally refined petroleum product, enabling it to meet the requirements of specific applications . . . .

by C. E. PRITCHARD

CHIEF LUBRICATION ENGINEER
REPUBLIC STEEL CORPORATION
CLEVELAND, OHIO

▲ MODERN design of steel mill equipment incorporating higher speeds, increased bearing loads, greater gear tooth pressures and wider operating temperature ranges, coupled with the ever present request for increased production from our older units, presents a major problem to both the lubrication engineer and the lubricant supplier. Quite often in order to meet these conditions it has been found necessary to augment the natural qualities of the conventionally refined petroleum oils with additives. These additives are designed to impart to the bulk of the oil certain specific properties otherwise absent or more usually present to an insufficient degree. With the addition of a relatively small percentage of the various types of additives the manufacturers are able to offer a finished product tailored to meet the immediate and in most cases the future requirements of the specific application involved. Probably the most important factor in compounded oils is the susceptibility of the bulk oil to the action of the addition agents. This resolves itself into a compatibility, in the sense of chemical activity, between the base stock and additives. Considerable research and field tests have in turn offered considerable assistance in minimizing the adverse reactions noted in the past in the usage of additives with respect to their compatibility.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

TURBINE OILS

The use of inhibitors in modern turbine oils has undoubtedly been one of the most important developments offered to the steel plant operator in recent years. Coming at a time when maximum service of turbine equipment was deemed mandatory to meet increased steel production demands, the added improvements including oxidation resistance, freedom from corrosion, excellent water repellancy characteristics and increased service life have minimized the costly delays during shut down periods as formerly experienced.

Successful performance of inhibited turbine oils depends upon the ability of the operator to secure a clean oiling system. As a means of accomplishing this end a program has been established for a complete cleaning and flushing of the turbine systems. Field experience has proven the need for treating the new turbine in the same category as the old with respect to the need for thorough cleaning. In order to provide an additional factor of safety an inhibited cleaning and flushing oil is employed for this work.

A typical example of the benefits derived from the use of an inhibited turbine oil might be better illustrated by the results of a routine check made on the physical characteristics of a turbine oil after 29,278 service hours, which are as follows:

TABLE I

OXIDATION INHIBITORS

ANTI-OXIDANTS	EXAMPLE
PHENOLS	BETA NAPHTHOL
AMINES	PHENYL-α-NAPHTHYL AMINE
METAL DEACTIVATORS	EXAMPLE
PHENOLIC IMINES	SALICYLADEHYDE-ETHYLENEDIIMINE
HYDROXY QUINOLINES	8-HYDROXY QUINOLINE
METAL PASSIVATORS	EXAMPLE
DISULFIDES	DIBENZYL DISULFIDE
SULFURIZED COMPOUNDS	SULFURIZED WAX OLEFINES
PHOSPHITES	TRIBUTYL PHOSPHITE
PHENOL SULFIDES	

Color, N.P.A. ..... 1½+
Appearance ..... Cloudy
Water, per cent ..... None
S.U.V. at 100 F 169
Neutralization No. ..... Lt. 0.05
Saponification No. 0.2

The unit involved is a direct connected 334-497 hp, 3630-4152 rpm condensing turbine driving a blower handling coke gas at the rate of 17,000-20,000 cfm. The oiling system is a combination of both circulating and batch with a rated capacity of 25 gallons. The average service life of the oil in this system, prior to the cleaning and provision of the inhibited oil was approximately one year. The expectant service life of the above mentioned inhibited oil remained an open question after more than three years service. Laboratory evaluation of the oil and an inspection of the entire oiling system were made on a monthly basis for the first year. Subsequent inspections have been made on a quarterly basis. It is believed that in this manner an ample measure of protection has been established regarding the possible replacement of the oil during future operations.

Antioxidants — The oxidation of highly refined mineral oil proceeds in general by an autocatalytic mechanism. This results in a relatively slow initial rate of reaction which increases as the reaction proceeds. The reason for this is that when a hydrocarbon molecule is oxidized it may be endowed with the ability to induce the oxidation of other hydrocarbon molecules rather than becoming inert with respect to the oxidation mechanism. Thus there can be set up through the reaction of one molecule a chain of reactions which may result in the reaction of many other molecules, each of which further propagate the chain. The number of single molecular reactions resulting from the oxidation of one molecule may therefore be in the thousands, and the observed increasing reaction rate becomes easily understood.

This chain mechanism which accelerates the oxidative deterioration of mineral oils facilitates, as well, its control. Antioxidants or oxidation inhibitors are chemical species which have a greater affinity for oxygen than the hydrocarbon molecules. They may be regarded as preferential oxidation acceptors. But in addition to being more readily oxidized, they do not produce activated molecules which can influence the oxidation of other molecules. Once completely reacted themselves, they are inert and hence they either prevent the formation of a chain or break a chain of reactions. A single molecule of an antioxidant can therefore prevent the reaction of thousands of hydrocarbon molecules. Thus, antioxidants in very low concentrations, of the order of 0.001 to 0.1 per cent, can prolong the life of an oil several fold. The gross effect of oxidation

Figure 1 — Illustrating the effect of different types of inhibitors in stabilizing oil. One inhibitor (phenyl alpha naphthylamine,) completely prevents oxidation for a time and then after an induction period oxidation becomes very rapid. The sulphur type inhibitor is effective over a longer period of time but it does not completely stop the reaction.

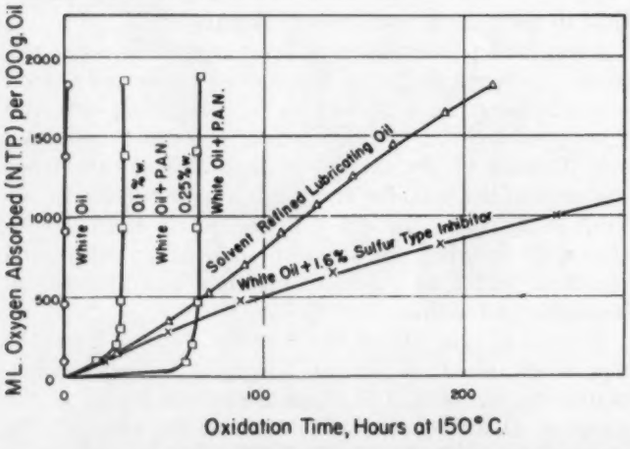
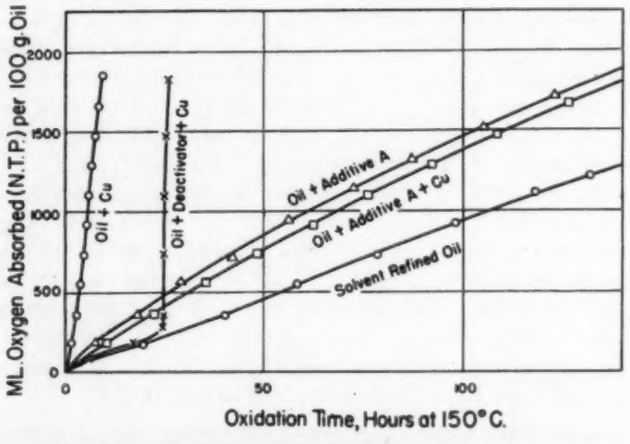


Figure 2 — Illustrating the effect of metal passivators and deactivators. It is seen that the deactivator completely eliminates the catalytic effects of copper for a short time but is then consumed and the reaction is rapid. The addition A, a passivator, does not completely eliminate the effect of copper but has a lasting effect.



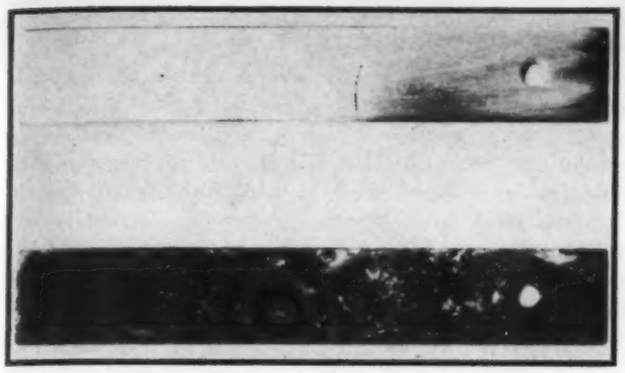
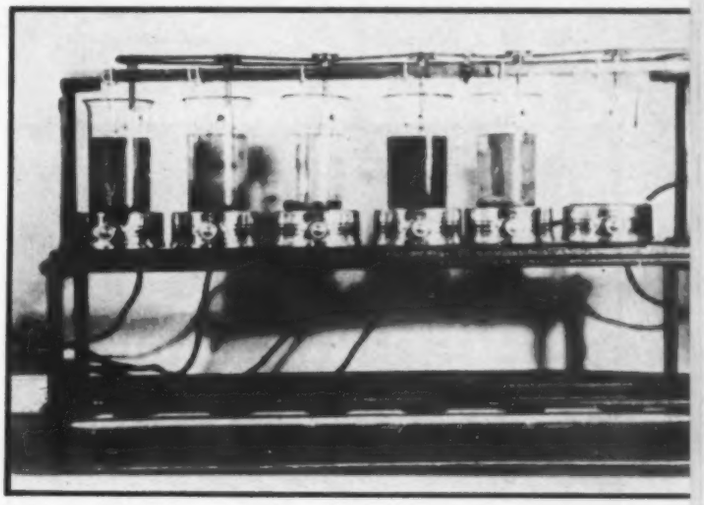


Figure 3 — The effectiveness of rust preventatives in protecting steel from corrosion is indicated by these strips. Both were subjected to the same conditions.

Figure 4 — View of a rusting test apparatus used by the laboratory to evaluate the antirusting properties of an oil. →



inhibitors is to maintain the rate of oxidation at a relatively low level for an interval known as the induction period, or until the concentration of antioxidant is depleted. After the induction period oxidation usually proceeds as it would have originally had the antioxidant not been present. In practical terms, the induction period of the oil represents its useful life, since once under way, oxidative deterioration rapidly renders the oil unfit for use.

Anticorrosive agents — Under this general heading are classed materials to prevent corrosion of metal parts by constituents present in a lubricant either initially or developed as the lubricant ages, as well as those materials which are designed primarily to protect metal surfaces from the effects of atmosphere and moisture either during service or storage. Common instances of the first category include the corrosion of hard metal alloy bearings of the internal combustion engine, the corrosion of bearings of rolling mill drives, etc. The corrosive constituents are most generally organic acids produced by the oxidative deterioration of the oil, or in the case of the combustion engine, by the incomplete combustion of the fuel. The general problem of bearing corrosion has been aggravated by various comparatively recent developments:

1. The necessary replacement of alloys, such as babbitt, less susceptible to corrosion, by harder metals and alloys which are prone to corrode, dictated by the development of higher powered and more highly loaded engines.
2. The tendency to refine oils more drastically removes constituents which would provide natural protection against corrosion.
3. The inclusion in heavy duty lubricants of detergents or peptizing agents which, while most generally not corrosive in themselves, curtail the deposition of lacquer or sludge on bearing surfaces which would prevent their corrosion by preventing the corrosive bodies from coming in contact with the metal.

The job an anticorrosive additive must do in protecting metal parts from corrosion can be accomplished in two ways: first, by preventing the corrosive agents from coming in contact with the metal, and second, by removing the corrosive agents from the medium. The first method is most readily accomplished by incorporating in the oil an agent which forms an impervious coating on the metal. This phenomenon is explained as a plating out of a thin film, molecular in dimension, on the metal surface, thereby preventing the direct contact of the moisture or acids with the metal itself. The similarity of such agents to metal passivators becomes at once evident, but the objective is different. In the case of anticorrosives, such a film must resist erosive action such as that of a journal against a bearing, otherwise weight loss possibly more severe than that of corrosion might occur. The second method can be accomplished by straight neutralization, such as reaction between an amine and an acid, or by metathesis between a metal phenate and a carboxylic acid (corrosive) to give a phenol (noncorrosive) and metal carboxylate. Additives which can neutralize corrosive acids are said to impart "reserve alkalinity" to an oil.

The protection of metal surfaces from the corrosive effects of moisture and air, although related fundamentally to the type of corrosion considered in the foregoing, is to a considerable extent quite a different problem. Protection of iron and steel parts from rusting constitutes by far the most important phase of this problem, it remaining essential, of course, that the preservatives must not affect adversely other metals. Metal wetting agents which are soluble in petroleum oils are employed as additives to prevent atmospheric corrosion. In general, they are compounds with a polar group, which attaches itself to the metal surface, on a large hydrocarbon molecule. The hydrocarbon portion of the molecule may be oriented away from the surface and thus form a coating hydrophobic but with an affinity for other hydrocarbon molecules.

For the displacement of water from metal surfaces, emulsifying agents are effective since they induce the water to go into the oil layer. As a common example of such materials, pretoleum sulphonates can be given. Natural fatty materials, both animal and vegetable, are used to a considerable extent.

An excellent example of protecting lubricated metal surfaces from rusting and atmospheric corrosion, without impairment of other qualities of the lubricant, is the protection of turbine systems. The formulation of

antirusting turbine oils is not in itself a difficult problem. However, preservation of the stability, lubricating quality and nonemulsibility characteristics as the oil is fortified with antirusting quality requires the careful balancing of several additives both as respects concentration and chemical nature. Similar problems also exist in hydraulic oils, heavy duty motor oils, etc.

Anticatalysts — The exposure of lubricants to metals during service is unavoidable, and the catalytic effect of metals on the deterioration of hydrocarbons is well known. There exist nonmetallic organic compounds which catalyze the oxidation of hydrocarbons, such as polysulphides, peroxides, etc.; however, such materials are present through either insufficient or faulty refining or are produced in the course of the oxidation of the oil itself.

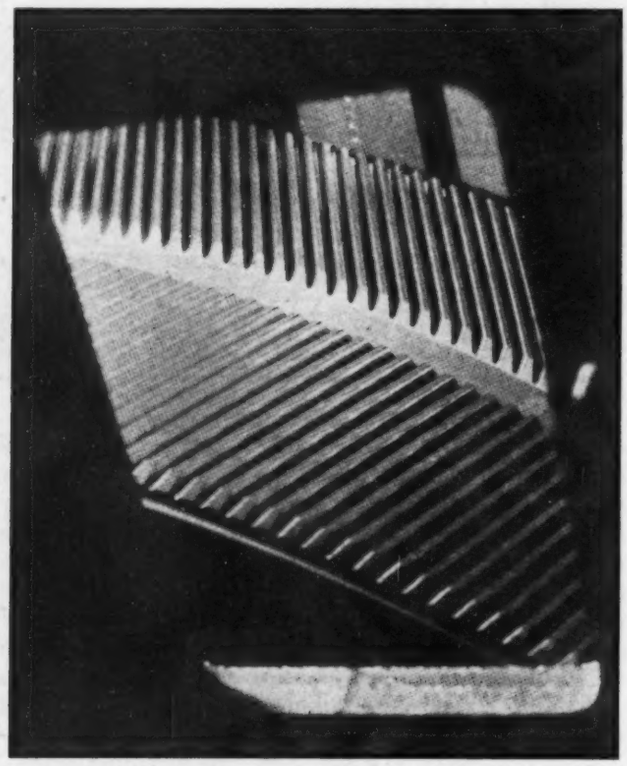
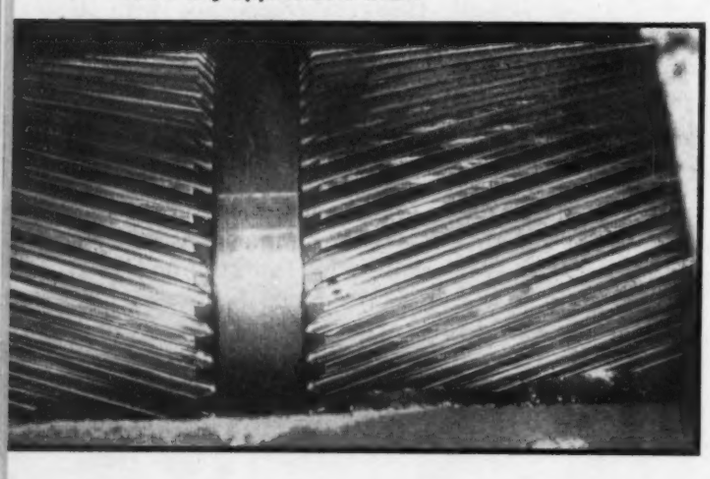


Figure 5 — This reduction gear set had three years of operation on an inhibited oil. An inhibitated cleaner was used to prepare the system before the initial charge of lubricant was used.

▲

Figure 6 — This high speed pinion had five years operation on an inhibited oil. Microscopic examination failed to show any appreciable wear.



Used mineral oils have a measurable tendency to dissolve metals, most commonly with the formation of metal soaps of acids which have been developed by oxidation of the oil. The solubility of metals and their solution rates in oils, while varying for different metals, are relatively low. However, even in extremely low concentrations of the order of a few parts per million, certain common metals exert an inordinate catalytic effect.

For example, copper which is most active catalytically in this sense, in a concentration of only one part per million can reduce the stability of a petroleum fraction by as much as 50 per cent. Iron and lead, while not as potent catalysts as copper, contact lubricants in relatively greater proportions, may be readily dissolved and are responsible for major adverse effects on the stability of petroleum products.

As a means of controlling the catalytic reaction of the various oils, metal passivators or metal deactivators are employed. The former is incorporated in the oil to form a coating on the metal surface which is impervious to those constituents of the liquid phase which induce the solution of metal. These materials are called metal passivators in the sense that they reduce the activity of the metal surface. Common among such agents are sulphur-containing molecules which form sulphide coatings on the metal. The problem of controlling the chemical activity of dissolved metals is handled by metal deactivators or compounds which render the metal-containing molecules inert. This can be accomplished in two ways, either by precipitating the metals from solution (metal precipitants) through the formation of insoluble compounds or by forming soluble, inert complexes. The latter mechanism is regarded as being based upon the formation of a complex which ties the metal firmly in one of its valence states. The ability of a metal atom to change valence states is associated with its catalytic activity, and the prevention of such oxidation-reduction curtails such activity. An interesting corollary of this postulated behavior of deactivators is that, having a strong affinity for metals, they may increase the rate of solution of metals from the elementary form.

EXTREME PRESSURE LUBRICANTS

Extreme pressure lubricants both in the fluid and plastic state have been universally accepted by the machinery builder and the lubrication engineer as the means of meeting the demand for lubricants which would protect the gears and bearings under the extreme loading conditions of the present day high speed mill. In addition to meeting these extremely severe requirements the lubricant supplier is requested to produce a product that is stable and non-corrosive at operating temperatures, will show no separation in service and will meet a wide variety of applications, which would in turn permit a lesser number of brands to be employed. The fact that production records are being exceeded almost daily is a very vivid indication that the lubricant supplier has fulfilled the request in a very satisfactory manner.

The prevention of wear of metal surfaces is a primary function of lubrication. The purpose of the lubricant is to "float" or separate the surfaces so that the load can be carried on a fluid film rather than by the surfaces themselves. In the range of fluid or hydrodynamic lubrication, the viscosity of the lubricant under the conditions of service is of fundamental importance. There are many instances, however, in which the loads and speeds are such that fluid lubrication cannot be maintained, and the metal surfaces come into intimate contact. This has been termed the region of boundary lubrication. Extreme pressure products (oils and greases) are far superior to conventional lubricants of the same relative viscosity or consistency in that they provide a means of assuring a satisfactory lubricating film to resist pressures of from five to seven times greater than would be possible where an ordinary lubricant was used, without scoring or seizure taking place.

In addition the ability to use a lighter viscosity lubricant offers a considerable savings in power due to reduction of fluid friction and excess churning loss of meshing gears and rotating ball or roller bearings. Thus it may be seen that where extreme cases of boundary lubrication are noted for periods of either long or short duration, some added anti-weld or extreme pressure properties are of utmost importance if trouble free operation is to be realized.

Antiwear agents — The mechanism of wear so far as it is understood is regarded as the actual rubbing away of "high points" on the metal surfaces. Under the extreme unit pressure at these high points the actual welding of the metal surfaces occurs with the subsequent tearing apart. As a consequence, friction is enormously increased and considerable damage may result to the surfaces.

TABLE II

Extreme Pressure Agents

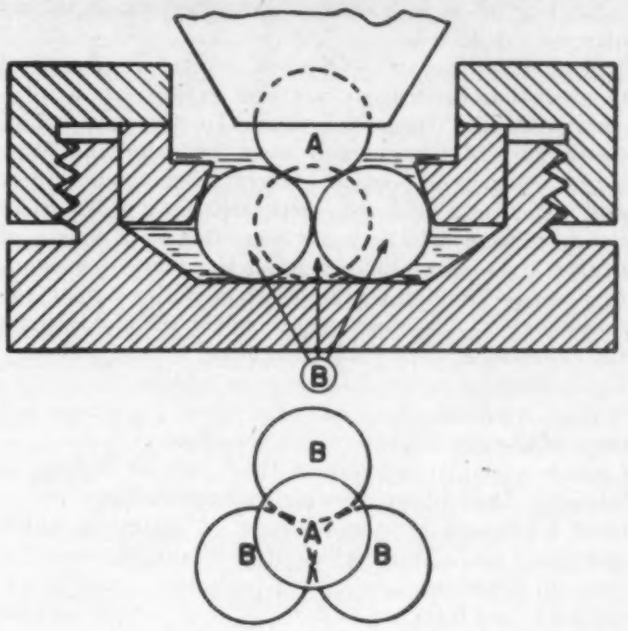
Type	*Example*
Sulfur Compounds	Dibenzyl Disulfide
Chlorine Compounds	Chlorinated Diphenyl Ether
Lead Soaps	Lead Naphthenate

Anti-Wear Agents

Type	*Example*
Phosphorus Compounds	Tributyl Phosphite
Arsenic Compounds	Triphenyl Arsine

Substances which form, probably by chemical reaction, films on the metal surfaces are employed as antiwear agents. Materials containing phosphorus and arsenic are commonly used, tricresyl phosphate being a representative type. For the purpose of clarification, antiwear agents might be classified in the category of a companion additive to those materials commonly referred to as an extreme pressure additive with the added line of distinction being offered, whereby the antiwear agents are to bridge the gap beyond the application limitations of the extreme pressure additives, as during periods of lesser load and higher speed.

The precise mechanism by which such additions curtail mechanical wear is not clearly established. Their action may be one of corrosion which tends to "dissolve" down the uneven high spots. Chlorine-containing



Four-Ball Bearing

Figure 7 — Illustrates the principle of the four-ball machine used in evaluation of the lubricating qualities of oils. The upper ball spins on the three lower balls at pressure ranging from 5000 to 400,000 psi. Circular scars are worn into the surface of the lower balls.

compounds are postulated to function by such a corrosive mechanism. For some cases it is held that the chemical nature of the film, which may be for example a sulphide of the metal, prevents the welding of two metal surfaces.

Another and particularly interesting view is the "eutectoid theory" which has been advanced for the action of phosphorous additions. The formation of a metal phosphide is postulated, which, being metallic in nature, alloys with the metal and lowers considerably its melting point. Under extreme pressures this induces plastic flow and aids in maintaining a polish on the metal surfaces.

The measurement of wear in the laboratory employs apparatus with which sliding or rolling friction between metal surfaces can be effected under controlled conditions of speed, load and temperature. Among many apparatus are the Timken, Falex, Almen and the Four-Ball machines, used for the study of wear. Wear can be measured either by the change in dimensions of the metal surfaces, by loss in weight of the metal or by analysis of the lubricant for dissolved or suspended metal.

A word should also be given about initial or "break-in" wear. With newly assembled parts, it is unusual to achieve so perfect a fit that negligible wear should occur. For the early stages of initial operation, wear is expected until the high spots are worn down and the assembly is brought into alignment. It is common practice to employ a "break-in" period when such wear is actually induced, so that when the equipment

is released to service it will be ready for duty under the conditions of high load and speed for which it was originally designed.

Antifriction agents — Of even greater fundamental moment than the reduction of wear in the use of a lubricant is the reduction of friction. To a certain extent the factors of friction and wear are interdependent, high coefficient of friction inducing high temperatures and initiating a chain of events that may well lead to increased wear. The decrease of friction is, of course, of utmost importance in decreasing the power consumption of steel mill machinery. To a major extent the development of power generators has depended upon the elimination of power losses caused by the necessary expenditure of energy to overcome friction.

Highly refined oils, it has been found, may have lost some of the constituents which are effective in reducing friction — or in other words, they may be lacking in lubricity. It has been possible to improve these petroleum lubricants by the addition of materials which effectively reduce the coefficient of friction between the moving metal surfaces. Most common among such materials are fatty acids derived from natural animal and vegetable fats. It is thought that the acidic group attaches itself to the metal and the hydrocarbon portion of the molecule is oriented into the lubricant phase. Dibasic acids, or monabasic acids with another polar group in the molecule such as a phenolic group, may be more effective than the simple monabasic acids, since multiple layers of molecules can be formed on the metal surface to provide a more stable matrix on which loads can be carried.

It might be expected that additives which reduce friction would simultaneously reduce wear. This is not necessarily the case. Fatty acids which are effective in reducing friction may through corrosive action actually increase wear. Further, the objective of simultaneous low wear and low friction is a complex reaction which is attainable through the use of both antiwear and antifriction additives in the same lubricant. This may be the result of the tendency of various types of molecules to displace each other, and it is fairly well established that the reduction of both wear and friction require the formation of films on the metal surfaces.

The measurement of coefficient of friction is carried out in the laboratory in the same or similar equipment as is used for the measurement of wear. In fact, both factors are usually measured simultaneously. From the dimensions of the apparatus and the determination of power or torque, the friction can be calculated.

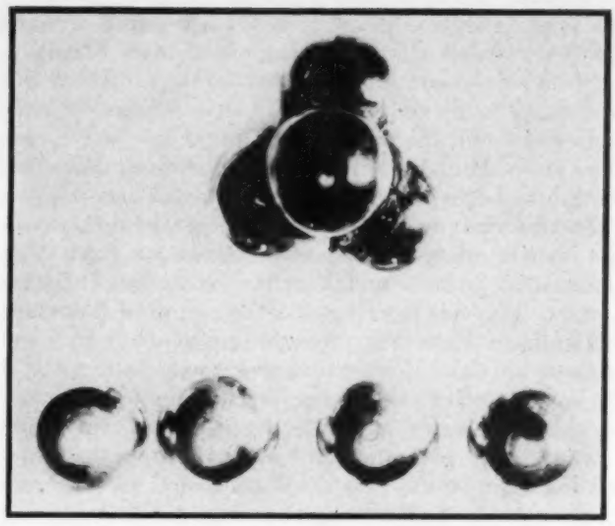
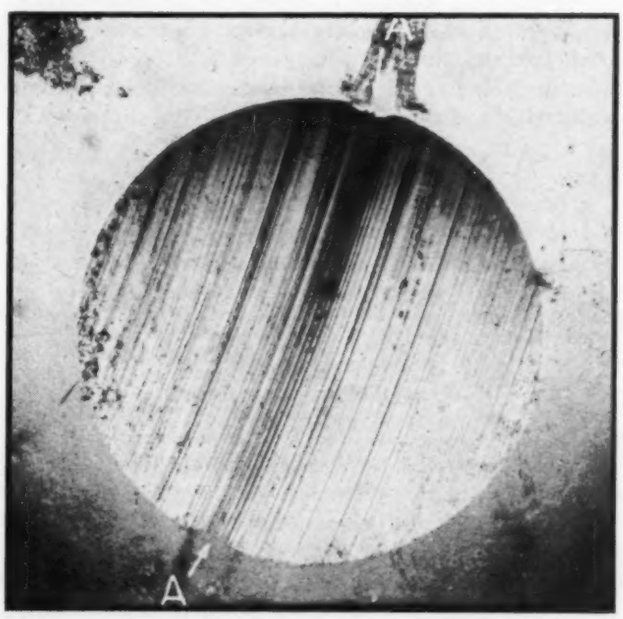


Figure 8 — The upper set of balls were used with undoped mineral oil under very high pressure. Friction was so great that the metal melted and the balls welded together. The lower set of balls were run at the same load as before, but with an extreme pressure lubricant. No welding occurred, but as seen, the usual wear took place. The loads on this test were not in excess of those encountered in certain types of gears.

▲

Figure 9 — An enlarged photograph of the wear scar on one of the three lower balls of the 4 ball machine. The diameter of this scar indicates the amount of wear occurring.



HEAVY DUTY ENGINE OILS

Extensive research into the metallurgical aspects of the heavy duty diesel and gasoline powered engines has provided an economical and highly efficient unit of power which is rapidly gaining a prominent position in the steel industry, especially in such operations as railroad switching service, locomotive cranes, bulldozers, scrapers, shovels, etc. Similarly a gradual improvement in the lubricant used for these various units was found necessary in order that difficulties imposed upon the lubricant either by a change in design or materials used could be satisfactorily provided for. Some of these changes have been of a minor nature whereas other changes have induced a considerable burden of responsibility upon the type of lubricant used:

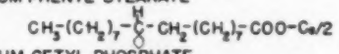
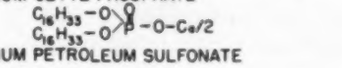
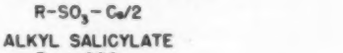
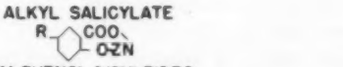
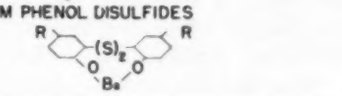
1. Increased ring temperatures have resulted in ring sticking problems.
2. Extended usage of the harder alloy bearing metals to meet the increased service requirement introduce a definite corrosion problem.
3. Higher operating temperatures have resulted in more rapid deterioration of the lubricant.

4. Supercharging has resulted in a tendency to accelerate deterioration.
5. Increased usage of special surfaces on pistons and cylinder liners has offered a major change with respect to sealing characteristics and metallic wear.

Detergents — As petroleum oils deteriorate, insoluble products of oxidation are produced which, as they deposit on the various surfaces, interfere with efficient lubrication, transmission of heat and in severe cases with relative movement of parts. This problem is particularly severe in internal combustion engines where it is aggravated by the effects of the incomplete combustion products of the fuel.

TABLE III

DETERGENTS

TYPE	EXAMPLE
METAL CARBOXYLATES	CALCIUM PHENYL STEARATE 
METAL PHOSPHATES	CALCIUM CETYL PHOSPHATE 
METAL SULFONATES	CALCIUM PETROLEUM SULFONATE 
METAL SALICYLATES	ZINC ALKYL SALICYLATE 
METAL PHENATES	BARIUM PHENOL DISULFIDES 

The alleviation of this problem has been achieved through the incorporation in the oil of materials which have the ability to peptize products of oil oxidation and hold them in suspension. An engine run on a sludging type oil soon becomes very dirty, lacquer appearing on the pistons and in the crankcase, with copious deposits of sludge in various parts of the engine. When an efficient detergent is included in the same oil the amount of lacquer and sludge is greatly decreased and the engine is maintained in a much cleaner condition. A corollary to the action of a detergent is that the oil itself, since it holds the products of oxidation in suspension, becomes very dark and dirty in appearance. However, the efficiency of the lubrication and cooling is increased. Detergent additives for the most part consists of metallo-organic compounds. Metal carboxylates and phenates are probably the most common.

The peptizing ability is attributed to the metal portion of the molecule which, it is thought, has the ability to attract and possibly absorb particles of sludge. The insoluble products of oxidation are thus kept in a state of high dispersion and are prevented from depositing on the lubricated surfaces. There are some nonmetallic detergents which are required for those cases in which an ash content is an objectionable feature. In general, nonmetallic detergents, of which lecithin is an example, are milder peptizing agents than are the metal-containing type.

Viscosity index improvers — All oils are affected adversely when subjected to either hot or cold applications. The severe service requirements of the internal combustion engine is one of the most exacting problems offered to the lubricant supplier in recent years in regard to meeting the wide temperature range demanded for satisfactory operation. Obviously, in order to meet the prevailing problem encountered in this regard, considerable thought and research were to follow relative to improved refining procedure, blending procedure, filtration, etc. The economics involved in extensive processing led the trend of thought toward development of an additive which would improve the viscosity index of an oil without necessitating the more drastic refining procedure heretofore demanded, hence, the present day usage of viscosity index improvers in motor oils. In addition, their field of application has been extended to include such services as hydraulic systems, electrical controls, shock absorbers or other such applications where temperature variations are great. The ability to provide better sealing, due to a minimum change in viscosity, and maintenance of fluidity at low temperatures are undoubtedly the most important function of this type of additive in an oil.

Pour point depressors — Low temperature starting conditions are extremely hazardous to the internal combustion engine unless due caution has been exercised to provide a suitable lubricant of free flowing characteristics to meet the ambient temperature encountered. Should the oil congeal, an interruption in the flow of oil from the pump to the bearings might occur which would result in excess wear and probable final destruction of the bearings themselves. The most common method used by the refiner to produce an oil satisfactory for low temperature operations has been to employ one of the several dewaxing processes in use at the present time. The use of a pour point depressor is offered as a means whereby the beneficial properties known to exist in the wax content may be retained with a lesser degree of dewaxing being found necessary to accomplish a resultant product with somewhat comparable properties.

The mechanism involved in the use of a pour point depressor is believed to be one of adsorption on the surface of the wax crystals, which in turn prevents their growth, thereby controlling the rate of increase offered by fluid friction which would otherwise be present in the oil during service application.

CUTTING FLUIDS

The cutting and shaping of metals in the steel industry has long been a study of infinite variety, both as to type of material to be processed and fluid to be employed to assure the most favorable results. The in-

TABLE IV

Viscosity Index Improvers

Type	*Example*
Polymeric Compounds	Polyisobutylene
Cellulose Esters	Cellulose Stearate

Pour Point Depressors

Type	*Example*
Alkylated Aromatics	Alkylated Naphthalene
High Molecular Weight Esters	Esters of Wax Substituted Phenols

creasing demand for better surface finish, closer tolerances, lower operating cost per unit and the inevitable higher machine speeds has resulted in a marked improvement in the cutting fluids found necessary to meet these conditions.

Cutting fluids are generally classified on the basis of their service requirements.

Light duty.

1. Straight mineral oils.
2. Soluble oils (conventional type).

Medium duty.

1. Mineral lard oil.
2. Lard oil (undiluted).

Heavy duty.

1. Sulphurized mineral oils.
   a. Dark (general purpose).
   b. Transparent (special service).
2. Sulphurized mineral lard oil
   a. Dark (general purpose).
   b. Transparent (special service).
3. Soluble oil (heavy duty type).

For the purpose of economy the cutting fluid must permit a maximum period between tool grinds, must effectively dissipate the heat generated between the tool and the chip, must reduce friction between the chip sliding along the face of the tool (thereby preventing the welding which would otherwise take place), effectively flush the chip away from the cutting zone and prevent the corrosion of the finished piece.

Extensive research has been conducted regarding chip formation and its relative control with the very gratifying results in a better surface finish being made possible. Tool shapes and grinding techniques have also contributed a great deal to better surface finish. Similar study of heat dissipation characteristics of the various combinations of oils and additives has also aided considerably in the reduction of tool cost.

The simple addition of sulphur in a mineral oil was probably the initial step in producing a cutting fluid with definite antiweld characteristics. It soon became apparent however, that the hazard of corrosion was quite prevalent where moisture was encountered. There followed in successive steps the cooking of sulphur in combination with mineral and vegetable oils; then later a sulphurization of animal, vegetable and synthesised fatty materials as a base stock for blending with the desired mineral oil.

The conventional type soluble oils, composed of an emulsifier base and light mineral oil, have a definite limitation with respect to service application. The theory involved is to provide a high degree of thermal conductivity where the service requirements are not severe and to this end very satisfactory results have been noted. However, more recent developments now offer a soluble oil which embodies a heavier oil and addition agents which enhance its properties to such an extent that several cutting fluid applications heretofore demanding a sulphurized mineral oil can now be very adequately provided for with the newer type heavy duty soluble oil.

An interesting sidelight in this regard is noted in our own organization. The problem noted involved a group of multiple spindle nut-tapping machines located in an older section of the plant where a wooden floor prevailed. Whenever the more severe requirements of tapping the harder steels were encountered it was found necessary to employ the use of a sulphurized mineral oil to eliminate damage to the taps. Subsequent operations soon made it apparent that a very definite safety hazard existed due to excess carry-over of lubricant on the finished product draining onto and saturating the wooden floor adjacent to the machines. Experimentation in the usage of the new type heavy duty soluble oil on this application indicated very clearly that a satisfactory finished product could be provided without the disadvantage of the oil carry-over as noted with the sulphurized mineral oil. In fact, closer study proved that a lesser number of grinds per turn were required as compared to the period when the sulphurized mineral oil had been employed. In addition, and of equal importance, was the elimination of the necessity for removing the excess oil such as was noted with the mineral oil before preparing the product for shipment.

INTERRELATIONSHIP OF ADDITIVES

It is evident that the various factors discussed herein are not independent. For example, both antioxidants and anticatalysts protect an oil against oxidative deterioration; metal passivators and anticorrosives may act in the same manner, that is, forming an impervious coating on the metal surface. These facts indicate the necessity of insuring that a combination of additives be compatible among themselves as well as being well suited to the base stock in which they are incorporated.

It is possible to find materials which will function, for example, as anticatalysts, anticorrosives and antioxidants; these are commonly termed "multifunctional additives." There has been some question raised as to the wisdom of incorporating into a single molecule several discrete functions. If this could be done without impairment of any of the qualities that could be achieved by separate additives, expense and manufacturing problems could be lessened materially. However, this factor is automatically controlled by the evaluation of the efficiency of additives, made upon the basis of practical performance.

DISCUSSION

PRESENTED BY

C. R. HAND, Lubrication Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

MAURICE RESWICK, Engineering Division, Standard Oil Company of New Jersey, Pittsburgh, Pennsylvania

W. H. MANDY, Lubrication Engineer, The Texas Company, Pittsburgh, Pennsylvania

C. E. PRITCHARD, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio

C. R. Hand: Mr. Pritchard has given us a very interesting and instructive paper, one which should have much value as a reference. The statements regarding turbine operations and the characteristics of the oil required to keep them operating satisfactorily cover many of the problems and the experiences we have

had at Sparrows Point. The physical and chemical reactions covered in the paper should give much help in determining the cause of oil sludging and breakdown. Oils which are designed to combat the conditions encountered can easily be obtained when the conditions causing failure are determined.

We have found that although iron is not as active in contact with oils as copper, more iron is exposed to the body of oil in reservoirs, bearing cavities, and pipelines. This results in much more iron being carried along with the oil. We have made special effort to prevent, as far as practical, this iron contact. All of our turbine reservoirs have been painted with protective coatings. All other areas that can be reached have had the same coatings applied. That includes the portions of the bearings exposed between the bearing and bearing caps, bearing wells, pipelines, down as far as we could swab them. In the case of many of the smaller lines, of course, we couldn't get any paint in and we still have slight iron soap formation.

The result of this precaution has been clean oil with physical characteristics very close to the original oil after three years of service. This has been maintained with a minimum amount of centrifuging.

Our experience with extreme pressure lubricants has not been entirely satisfactory in preventing damaged equipment. Some equipment has failed due to overloading with extreme pressure compound in the equipment. We have found other machines which have been using extreme pressure compound ran just as well without it. Care should be exercised when such compounds are used to see that the same compound is applied each time an addition to the unit is made. Some violent reactions may result from mixing one or more different compounds. Mr. Pritchard has made it clear there are many of these compounds, and it can easily be seen what may happen. Our policy is to use extreme pressure compound where it is necessary and keep it out of all equipment that does not require this extra load-carrying compound.

Maurice Reswick: Mr. Pritchard's paper marks a new high level in the profession of lubrication engineers in the steel industry. In his supervisory capacity as a user of lubricants, Mr. Pritchard is certainly well qualified to talk on this subject. He presented a review of the accomplishments of the research laboratories of the oil industry, explained the fundamental theory of additives, and showed how these improved lubricants perform on actual applications. We should have more papers of this type from operating men if we are to gain recognition and if we really wish to raise the art of lubrication to the level of other scientific and engineering activities.

There is an analogy between steel and lubricants. In the metallurgical art of steel making we make use of iron as the base, and by adding carbon, nickel, chrome, molybdenum, and other alloys, we obtain steel which meets definite requirements. Similarly, in the art and science of lubrication, starting out with petroleum oil as the base, we impart special properties by adding certain ingredients or chemical compounds for a specific purpose.

In keeping abreast of new developments in machine design and production, there will always be corresponding developments in the art and science of lubrication to keep the plant lubrication engineer and the petroleum industry engineer busy at all times.

In the section of his paper on turbine oils, Mr. Pritchard stresses the importance of maintaining a clean oiling system if we are to get the most benefit from inhibited oils, and this is worth repetition. He cites an experimental turbine installation in which the life of the oil has already tripled, as compared with former practice, and it is still going good.

Mr. Pritchard has given us a lucid explanation of the manner in which additives retard or eliminate oxidation and corrosion. We should like to add that it is also extremely important to minimize or eliminate entirely the rusting which takes place on metal parts which are not bathed by the oil in the system. This has been successfully overcome by applying a suitable rust preventive coating which is impervious to both oil and moisture, and does not react chemically with the oil. Mr. Hand has already mentioned the success which he is having with a coating of this type.

I might also add that the inside surface of the sump tanks of circulating oiling systems which is above the oil level frequently develops corrosion due to atmospheric moisture and the oil becomes contaminated with particles of iron rust, which reduces the resistance of the oil to oxidation, lowers its demulsibility, and promotes sludging, all due to the formation of iron soaps. It is highly desirable to coat the inside of all oil sump tanks with the rust preventive material mentioned.

Mr. Pritchard mentioned only the most important additives to lubricating oils. There are many others which are still in a more or less experimental stage, such as additives to reduce foaming, break emulsion, make emulsions, etc.

W. H. Mandy: Mr. Reswick and Mr. Hand have already mentioned the problem of rust forming in turbine-oil reservoirs above the oil level. Even with the use of inhibited turbine oils, this problem is encountered, especially in marine service and in coastal areas where the climate is very humid. I believe the most satisfactory solution is to paint these exposed surfaces with an oil-insoluble paint.

Mr. Pritchard brought out the importance of thoroughly cleaning the oil circulating systems on turbines before installing inhibited oils. This is a very important point and one that should be stressed if best results are to be obtained. Field tests show that, where the old oil was merely flushed out and new inhibited turbine oil was installed, the neutralization number increased more during the first month of operation than it did during the next six or seven months. We assume that this initial increase in neutralization number occurred during the first few days of operation and believe it was due to deposits which remained in the system when the old oil was flushed out. I believe the time and expense of dismantling and pickling the oil piping and coolers is warranted even though a low viscosity inhibited flushing oil is used to flush out the system after removing the old oil.

On the turbine that was mentioned in the paper (I believe it was a blower), the results were really remarkable. How much make up was required in that system?

C. E. Pritchard: The make-up on this system is approximately 20 gallons per month. However, as mentioned before, the system is a combination of both

circulation and batch and actually involves two adjacent units each of 25 gallon capacity with one rest tank of approximately 400 gallons capacity for the three units. That portion of the oil being subjected to the most severe service would be confined to the circulating system of the unit itself with a rated capacity of 25 gallons.

The point I wish to bring out at this time is the fact that under similar operating conditions both the oil and oil system remained free of sludge and other products of oil deterioration as noted previously after approximately one year's service. Furthermore, there is no indication to date as to these products of oxidation being formed in excess after more than three years service operation since cleaning the oiling system and using an inhibited oil.

Wasserman DISCUSSION

(*Continued from page 74*)

of any type of welding rod, because there are so many things to know about a rod and only a research department which keeps on its toes and follows the applications can always point out the most valuable points about the procedure itself.

Regarding the fatigue strength of joints made at low temperature, one thing that is certain and evident is the fact that the use of lower temperatures means that the changes in the parent metal are not so great. Sometimes you can avoid them completely. Sometimes they are present in a lesser degree.

Therefore, particularly on malleable iron or high carbon steel for instance, where fusion welding is not recommended at all, fairly good results are obtained at low temperature, especially if the proper procedure is observed, and the procedure in this case is to try to keep the heat down to prevent an excessive or unnecessary amount of heating.

As with every process, there is the question of the joint design used. Lapped joints naturally will stand more. The larger the surface of contact, the better the flow of the stress.

The great smoothness of these joints has a good effect on fatigue strength. They do not show sharp edges like fusion welding does, so even if they are left unmachined, the very smooth fillets obtained have a great deal to do with fatigue strength. We have seen that occur, particularly in joining sheet metal such as aluminum or even steel, copper, bronze, etc.

The question of abrasion resistance of these alloys is a big special field and it is very difficult to answer the question immediately. We have tried to develop first four different types of hard low-melting alloys. One is the general type. It is an iron alloy of a low alloy content, for cost reasons. Then we have another alloy which contains manganese and is work hardening. A third type is for tools and is a modified alloy but heat treatable. The fourth type is richer in alloy, like nickel for instance, and answers, to a larger degree, problems where corrosion are involved together with hardness.

We are still working on a heat-resistant alloy. We are not ready on that yet, but that is a large field, as I see it.

Jackson and Whiting DISCUSSION

(*Continued from page 69*)

adjustment which could be made by someone with authority. The means for making this adjustment might even be kept under lock and key. Such an authorized overload could be safely lowered because of the inherent characteristics of the new system.

Cranes have been pulled off their runways by attempting to lift loads which are fastened down. The use of the new system prevented the possibility of this happening recently in a plant when it became necessary to move a machine tool with a weight about equal to the rated hook load. All holding down bolts were removed from the tool and a pull equal to the stalled load capacity failed to lift it. An inspection showed that excessive grouting had covered the flanges around the base of the tool and had cemented it to its foundation. On breaking up the grouting with sledge hammers the tool came up easily.

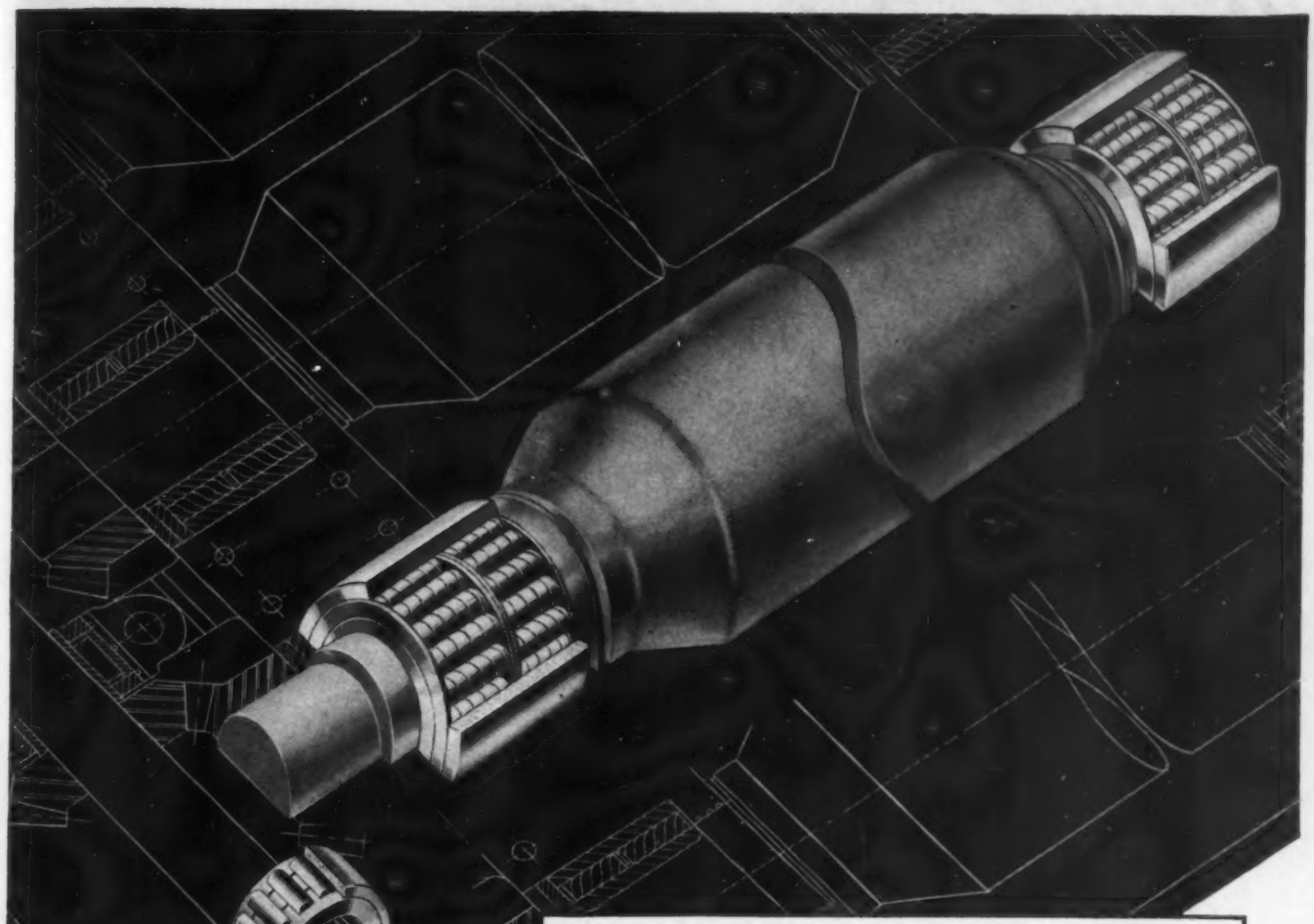
Answering Mr. Risler's question about the lowering curves in the third quadrant, they are, as he suggests, quite similar to the curves in the fourth quadrant. The only operating conditions for which the characteristics lie in this quadrant are when accelerating the empty hook or a very small load downward or when lowering an empty hook or small load at a steady speed. Under normal operating conditions, loads of any magnitude can not be lowered in this third quadrant. The curves are shown in Figure 8 accompanying this discussion.

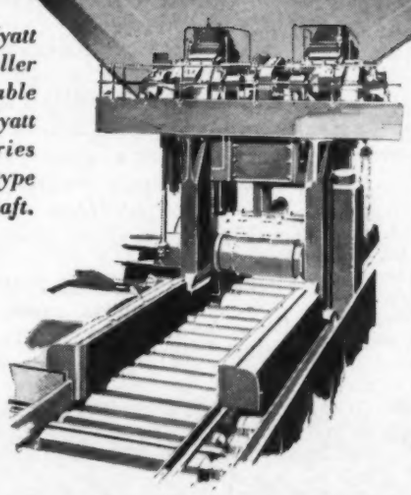
Mr. Risler also asked about the method of limiting the stalled load where the margin above rated load is small as shown on Figure 2. Since this margin is less than can be obtained by the inherent characteristic of the equipment, a relay is necessary to obtain this low stalling limit. Obviously, this relay must operate as a function of load.

Another question referred to weight comparison between the proposed system and a dynamic braking hoist control. The difference is not as great as might be expected because the weight of the high speed motor-generator set is offset to a considerable extent by the heavy resistor with its supporting frame and cables and by the heavy contactor panel used with a dynamic braking drive. A quick check indicates a 30 per cent increase for the new hoist system or approximately 1800 lb heavier with a 65 hp hoist drive. In cubic space required it is reasonable to expect that it may even favor the new system on account of the space required to mount the large hoist resistor with its supporting frame (as used on a dynamic braking drive) because of the necessity for providing ample ventilation to dissipate the losses in the resistor. With the new system these losses are returned to the power supply. The panel used with the new system will require less than half the space required for the dynamic braking panel.

L. R. Milburn: Where do you put the motor-generator set?

J. A. Jackson: On the bridge runway. The set is put on a self-supporting base. We have had five in our Fort Wayne plant for nearly two years and have had no trouble of any kind.





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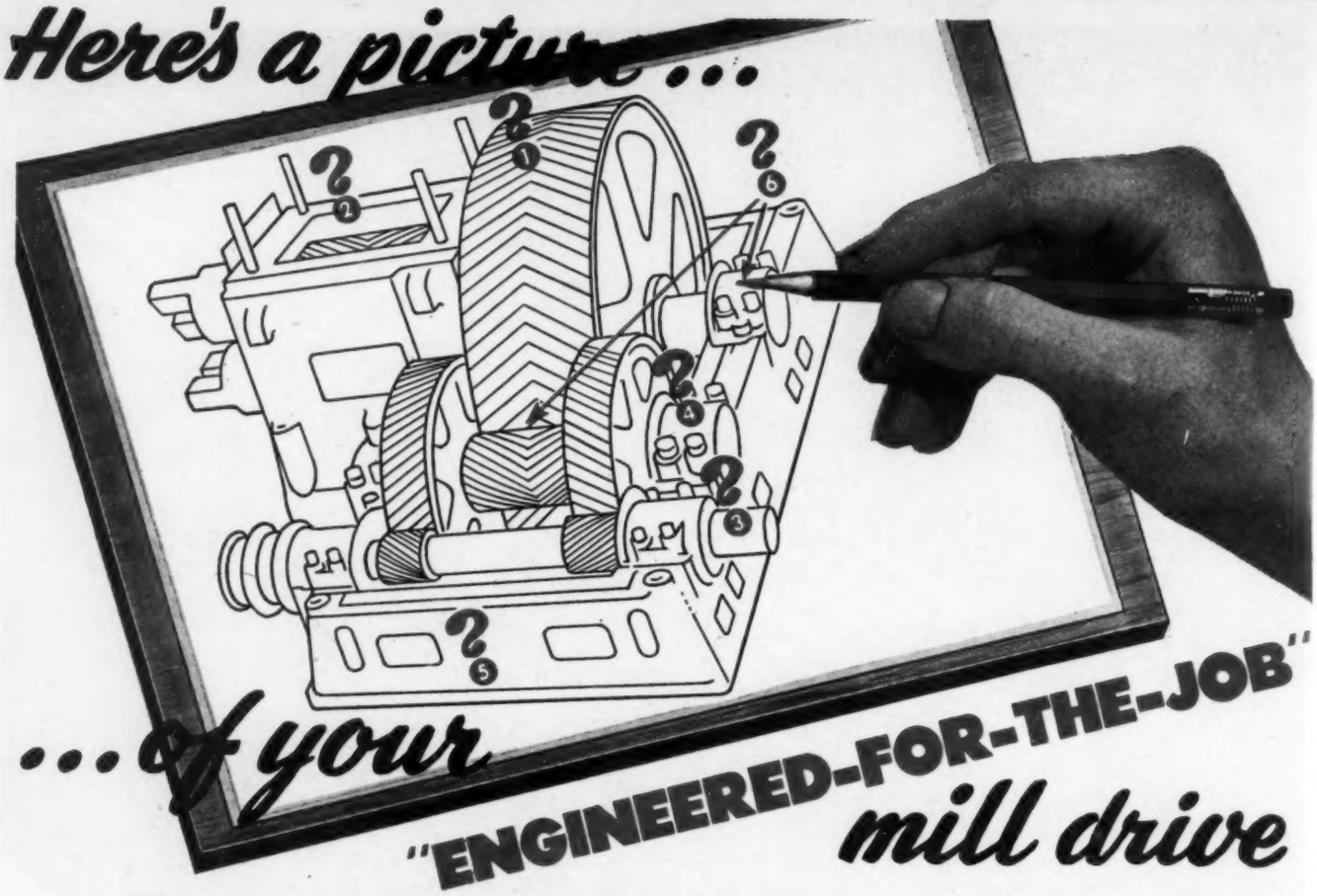

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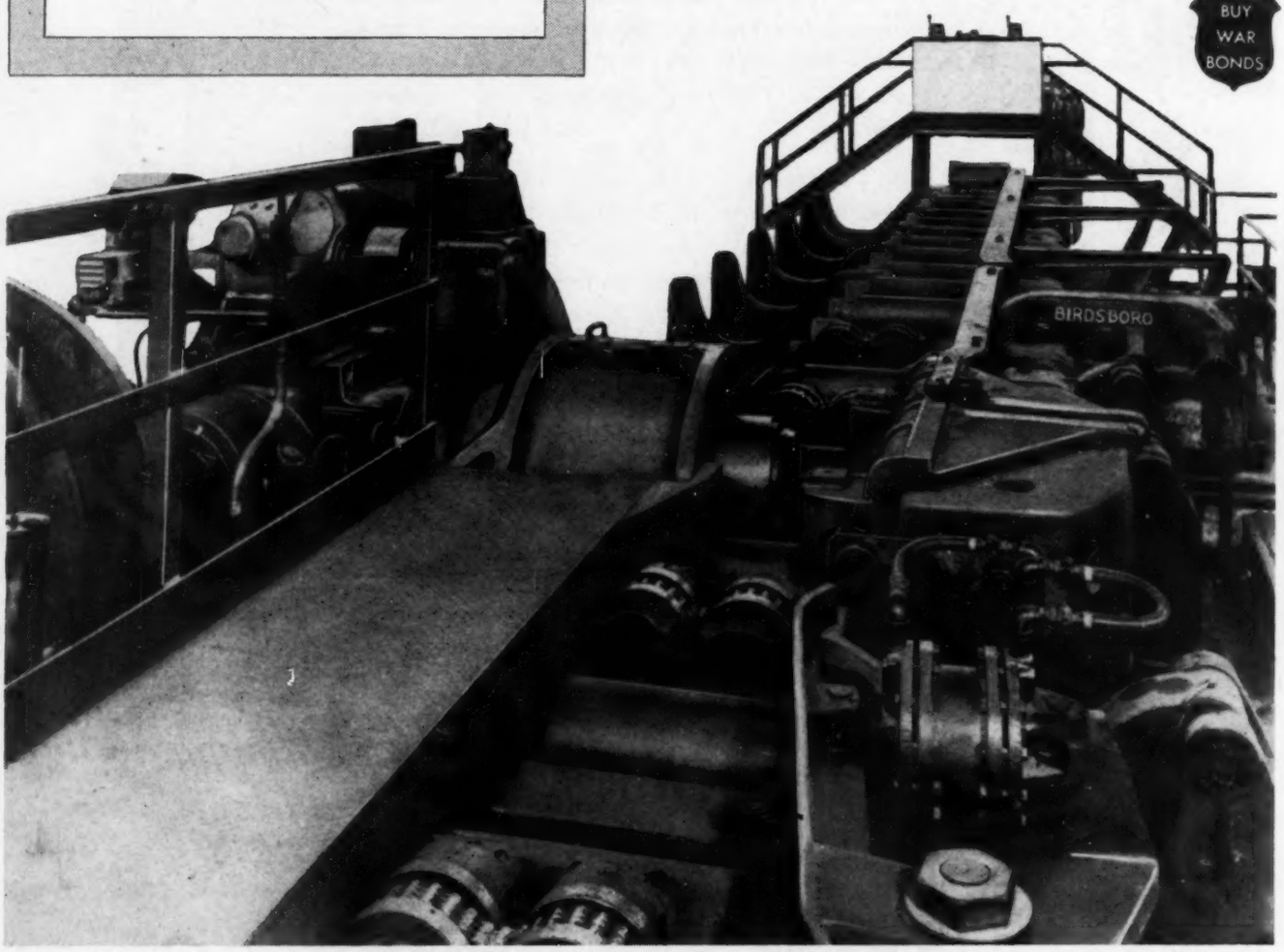

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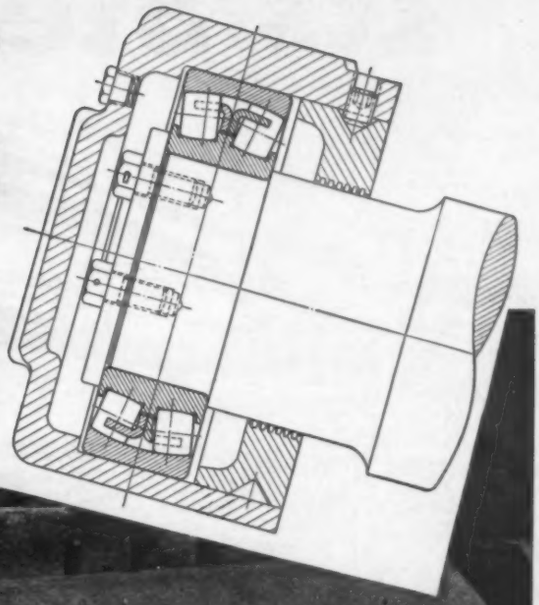

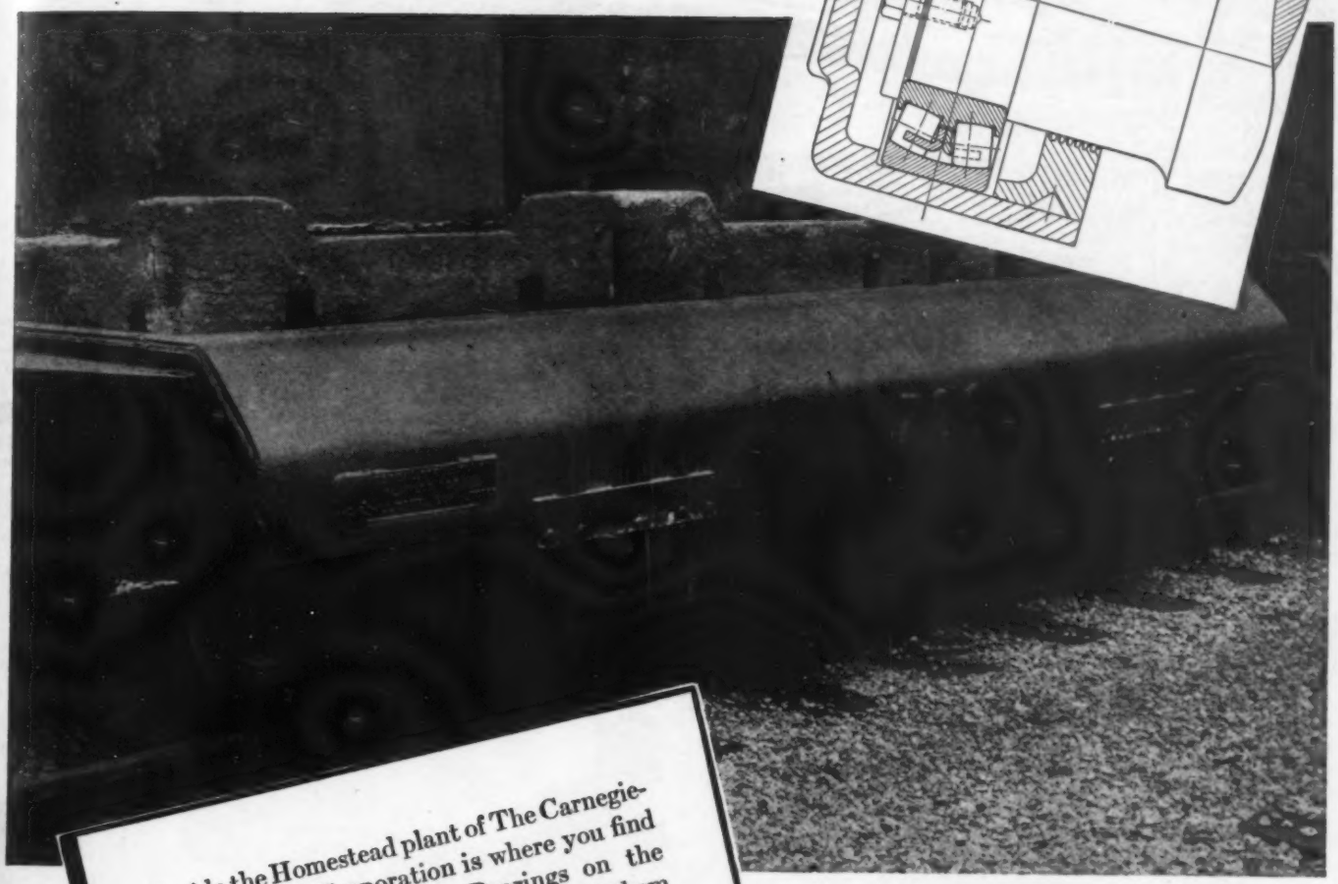

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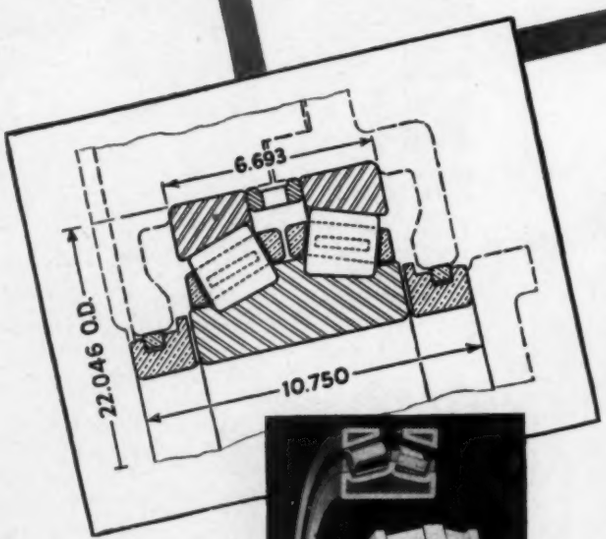
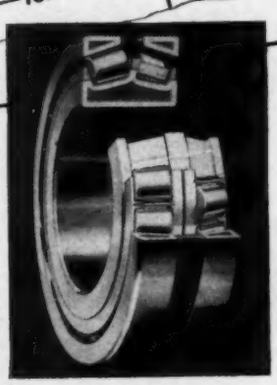
BEST FOR BACK-UP ROLLS

CHROME NICKEL STEEL ROLL NECK BEARINGS HELP SET PEAK TONNAGE RECORDS





Torrington's two-row tapered roller bearings made of S.A.E.-3310 steel (with higher nickel content), carry the thrust loads imposed on the back-up rolls of this 80" four-high continuous hot strip mill. They provide a much-needed anti-friction application which helps achieve peak wartime tonnages. Features include simplicity of design, controlled lubrication and clearances which permit ready removal from roll necks. Each bearing has a thrust load capacity of 220,900 pounds at 100 r.p.m.—employing 23 rollers, 2¼" long by 2" in diameter, in each of the two rows.

Supplying the steel industry with large custom-made bearings for heavy-duty, high-speed mill operations is an important part of Torrington's Bantam Bearings Division service. Other important applications include roll necks, edgers, screw downs, pinion stands, shears, and sheet levelers.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

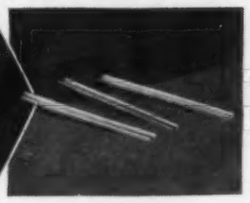
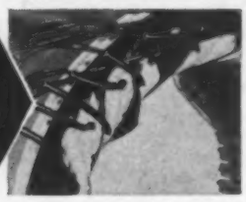
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

Thorough Insulation of Windings keeps Wagner Motors on the job!

THE windings of Wagner motors are thoroughly insulated with liberal quantities of the highest-quality materials. Wagner engineers will not permit the use of insulation which is barely adequate for ordinary service. They insist that all windings shall be thoroughly insulated so that Wagner motors will render dependable service even under the most severe operating conditions.

Illustrated and described below are a few of the reasons why the insulation on Wagner polyphase stator windings of the diamond type virtually precludes the possibility of failure.

POSSIBLE CAUSE OF GROUND	WAGNER INSURANCE AGAINST GROUND	POSSIBLE CAUSE OF SHORT CIRCUIT	WAGNER INSURANCE AGAINST SHORT CIRCUIT
Slot cell cut by core iron.	Smooth core and slots.	Contact between turns in coils.	Heavy coating of synthetic varnish on wire.
Slot cell torn during windings.	One piece, tough, cuffed slot cell.	Contact between coils in slot.	Heavy, tough separator in slot.
Creepage through mouth of slot.	Inverted cell over coil.	Contact between ends of coils.	Varnished-muslin phase-sheets.
Creepage caused by dirt on winding.	Coils completely taped and varnish-treated.	Contact between coil connections.	Varnished-muslin insulating-tubes.

29 BRANCH OFFICES

Wagner maintains 29 branch offices located in principal cities. Each office is manned by trained field engineers who will gladly consult with you.

M 45-5

Wagner

ELECTRIC CORPORATION

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

OTHER WAGNER PRODUCTS

Write for literature on Wagner Motors, Transformers, and Industrial Hydraulic Braking Systems.

for Safe, Positive Control

Specify

Hunt manufactures single and double solenoid operated air valves in standard and special sizes. The *Quick-As-Wink* design incorporates simplicity, trouble-free service, and ease of application.

Quick-As-Wink
Double Solenoid Operated Air Valves

Hunt's double solenoid valves serve as a safety factor and save time and money in air operations.

For example, the *Quick-As-Wink* valve can be mounted near the cylinder and you can install remote control. This hook-up saves the time and air required to fill the lines between the valve and the cylinder.

If you have a specific application on which you would like to have our recommendations on solenoid controls, advise us.

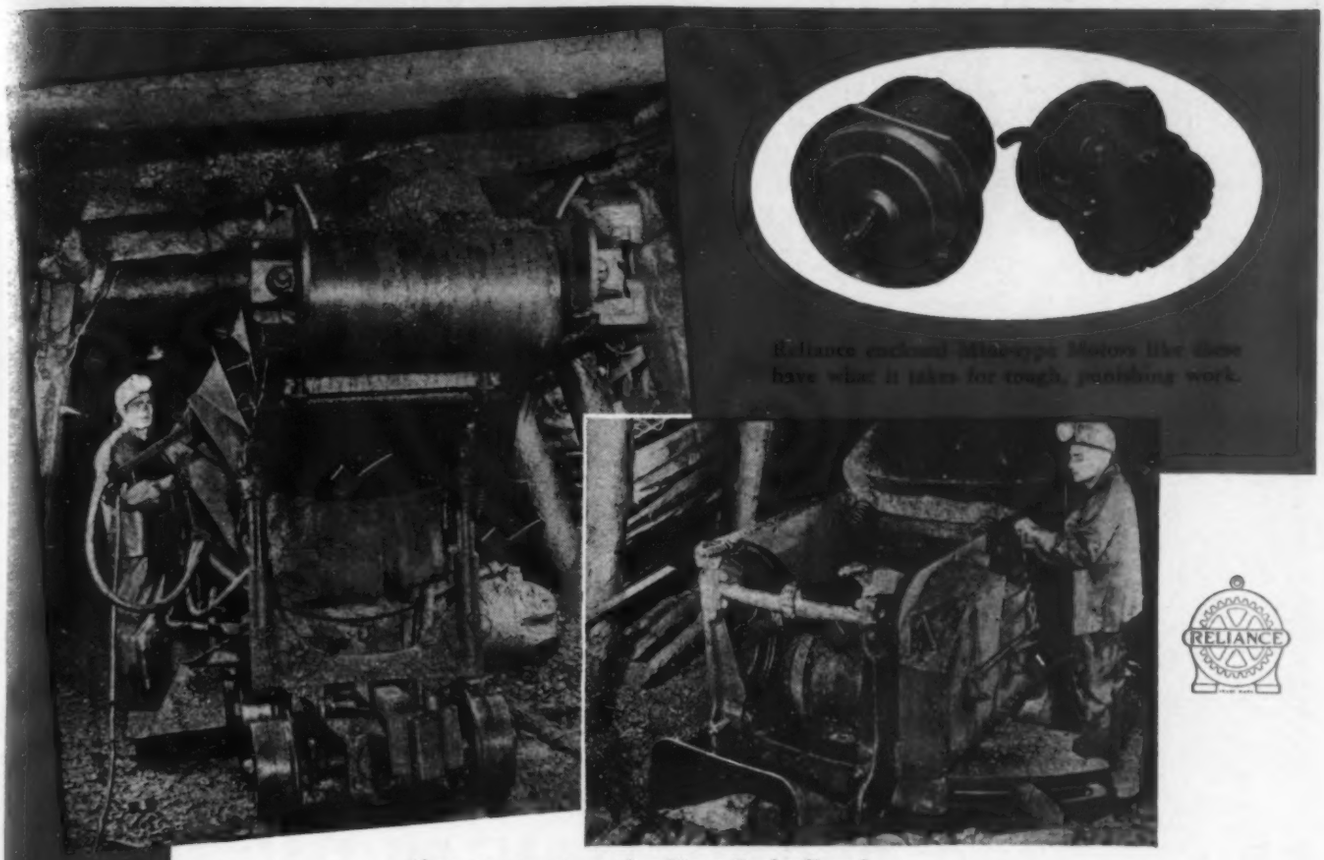
Write for the Quick-As-Wink catalog which includes *complete engineering data.*

THE HIGHER THE PRESSURE — AIR WATER OIL — THE TIGHTER THE SEAL

C. B. HUNT & SON

1863 E. PERSHING ST., SALEM, OHIO

Quick-As-Wink CONTROL VALVES



Above are two views of an Eimco RockerShovel.
Arrows indicate locations of Reliance Motors.

Here's Where RELIANCE MOTORS REALLY TAKE A BEATING!

● Eimco RockerShovels work far underground. Their job is to scoop up the ore and rock, loosened by drilling and blasting operations, and load it into cars. It is tough, dirty, wet, bruising work, which is being handled with 100% satisfaction through use of Reliance Motors that are specially designed, both electrically and mechanically, for such duty.

Reliance Motors have proved that, in this punishing service, they can both outperform and outlast other types of motors formerly used. And Reliance installations are standing up equally well in many other tough assignments in many industries.

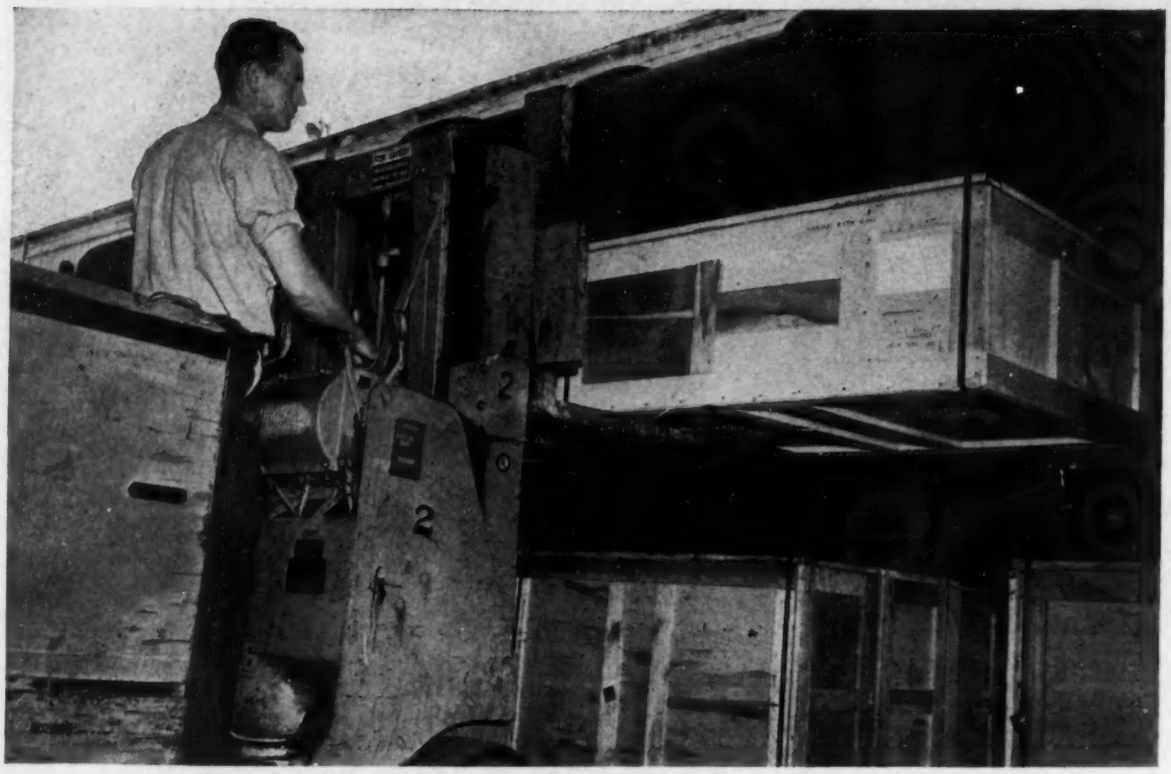
Whenever you have need of motors that can really take a beating—or, for that matter, whenever you need motors for any industrial use—it's a good rule to call in a Reliance Application Engineer. He's a man worth knowing.

RELIANCE ELECTRIC & ENGINEERING CO.
1084 Ivanhoe Road • Cleveland 10, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S. C.) • Houston • Kalamazoo • Los Angeles • Minneapolis New York • Philadelphia • Pittsburgh • Portland (Ore.) • St. Louis • San Francisco • Syracuse • Washington, D.C. • and other principal cities.

RELIANCE MOTORS

"MOTOR-DRIVE IS MORE THAN POWER"

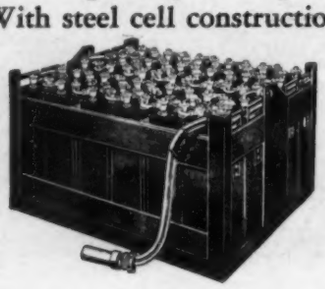


PROTECTING PRODUCTION PROMISES

Loading and unloading cars, keeping machines and assembly lines adequately supplied 24 hours a day are jobs in which the battery industrial truck excels because of its inherent dependability and high availability.

With batteries exchanged two or three times a day, the truck is kept continuously supplied with power. While one battery is being charged, another operates the truck. Except for the few minutes needed to change batteries, the truck need not stop for servicing the power unit. Its electric-motor drives have a minimum of wearing parts and are inherently simple and trouble-free. The truck starts instantly; accelerates smoothly; operates quietly; gives off no fumes; consumes no power during stops. Thus it is well adapted to the stop-and-go characteristics of material-handling work. Not only does it make efficient use of power but the current used for battery charging is the lowest-cost power available.

Altogether the battery industrial truck is one of the most dependable and most economical methods of handling materials — especially when powered by Edison Alkaline Batteries. With steel cell construction, a solution that is a natural preservative of steel, and a foolproof principle of operation, they are the most durable, longest lived, and most trouble-free of all types of batteries. *Edison Storage Battery Division of Thomas A. Edison, Inc., West Orange, N. J.*



In Industrial Trucks, Alkaline Batteries Give You These Important Advantages

- They are **durable mechanically;** grids, containers and other structural parts of the cells are of steel; the alkaline electrolyte is a preservative of steel.
- They can be **charged rapidly;** gassing. cannot dislodge the active materials.
- They **withstand temperature extremes;** are free from freezing hazard; are easily ventilated for rapid cooling.
- They are **foolproof electrically;** are not injured by short circuiting, reverse charging or similar accidents.
- They can **stand idle indefinitely** without injury. Merely discharge, short-circuit, and store in a clean, dry place.
- They are **simple and easy to maintain.**

Edison
ALKALINE BATTERIES

Longer Resistor Life...

FROM Nonbreakable MATERIALS

★ ALL STEEL CONSTRUCTION
★ MICA INSULATION
★ RUGGED TERMINALS
★ PROVISION FOR EXPANSION
★ ADEQUATE VENTILATION
★ UNAFFECTED BY VIBRATION
★ MOISTURE RESISTANT
★ CORROSION PROTECTED

Steel and Mica, the two basic materials entering the construction of P-G Steel Grid Resistors, are the foundation for longer resistor service. P-G uses these materials in a unique design to provide both for expansion and for maximum ventilation. For more detailed information, ask for a copy of Bulletin No. 500 ★ ★ ★ ★ ★ ★

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

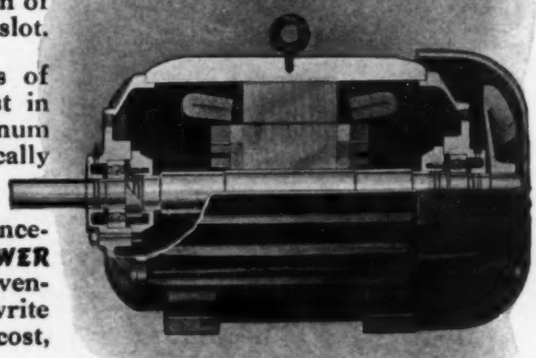
• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

...and after installation, you can forget a SEALEDPOWER MOTOR

The Crocker-Wheeler **SEALED-POWER** Motor makes the maintenance man's job easy. Here's why:

1. The totally-enclosed frame seals out harmful foreign matter. There is no danger of oil, corrosive liquids, acid or alkali fumes, air-borne moisture, steam, conducting dusts or metal chips, for example, causing premature breakdown of windings.
2. There are no ventilating passages in the frame to require periodic cleaning. Cooling air is blown over the outside surfaces of the motors, not through the frame.
3. Patented *Grooveseal* bearings require re-greasing only once a year or even less frequently. Seal permits use of softer grease, for better lubrication and longer bearing life. Retains grease.
4. Vacuum impregnation of windings reduces hotspot temperature and lengthens insulation life. Prevents vibration of wires inside or outside of slot.
5. Bars, fans and end rings of *Alucast* rotor are die cast in one operation from aluminum alloys, forming a practically indestructible rotor.



And yet, with all these maintenance-cutting advantages, **SEALEDPOWER** Motors cost no more than conventional fan-cooled types. Why not write for descriptive literature? No cost, no obligation.

CROCKER-WHEELER

A Division of JOSHUA HENDY IRON WORKS

AMPERE, NEW JERSEY

Branch Offices: BOSTON · BUFFALO · CHICAGO · CINCINNATI · CLEVELAND · DETROIT · LOS ANGELES · NEW YORK · PHILADELPHIA · PITTSBURGH · SAN FRANCISCO · WASHINGTON

STEP UP YOUR TONNAGE
STEP DOWN YOUR COSTS

You can do both in one simple step—just install N-B-M #200 Bronze next time you need new mill roll bearings.

They are rolling up new records fast:

- **10 times longer life—increasing total tonnage**
- **Substantial savings in maintenance and power**
- **More uniform gauge—fewer rejections**

as compared to conventional babbitted shell bearings with brass inserts.

One of our engineers will gladly step in and help you set similar records. May we send him soon?

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BRONZE BEARINGS • COPPER CASTINGS

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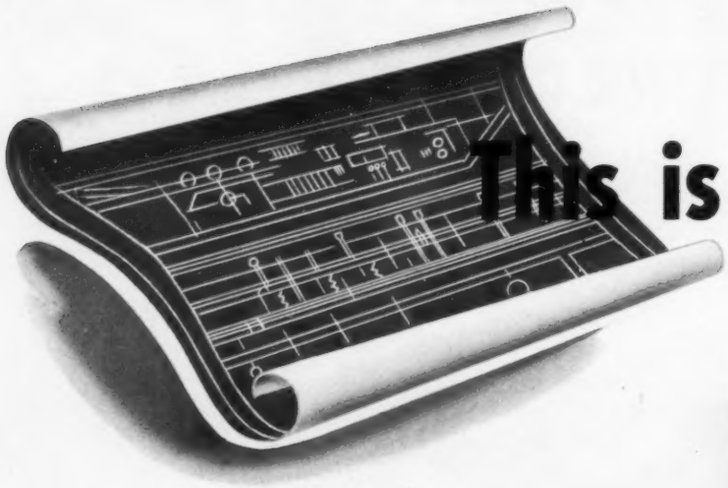

This is one of the m

MOST steel mills grow and expand through the years. It is hard to plan ahead for a half century and leave space for all the things that may develop, so there often isn't enough room for long-established mills to maintain a perfect production arrangement. But at this steel mill, engineers were "given their heads" and allowed to plan the most efficient lay-out they could, and to build it all at once.

The coke plant comprises 252 Koppers-Becker Underjet Ovens with Waste-gas Recirculation in four batteries. The last of these recently went into operation. Two of these batteries may be underfired with blast-furnace gas or coke-oven gas as required to maintain the fuel balance of the mills.

The coke plant includes complete Koppers coal- and coke-handling systems, a byproduct plant, a Koppers Vapor-recirculation Dephenolization unit, a Koppers benzol plant equipped to produce motor fuel and nitration-grade light oils, a naphthalene plant, and two Koppers waterless gasholders, one with a capacity of 500,000 cu. ft. and one of 1,000,000 cu. ft.

The ovens carbonize 1,800,000 net tons of coal per year, and make 1,132,000 net tons of coke, 20,000,000 gal. of tar, 24,000 net tons of ammonium sulfate, 4,600,000 gal. of motor fuel or benzol, 1,140,000 gal. of toluol, 320,000 gal. of xylol, 265,000 gal. of heavy solvents and 265,000 gal. of naphthalene, and over 20 billion cu. ft. of gas.

BUY WAR BONDS—AND KEEP THEM!

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

K O P P E R S C O M P A N Y , I N C

he nation's biggest new coke plants

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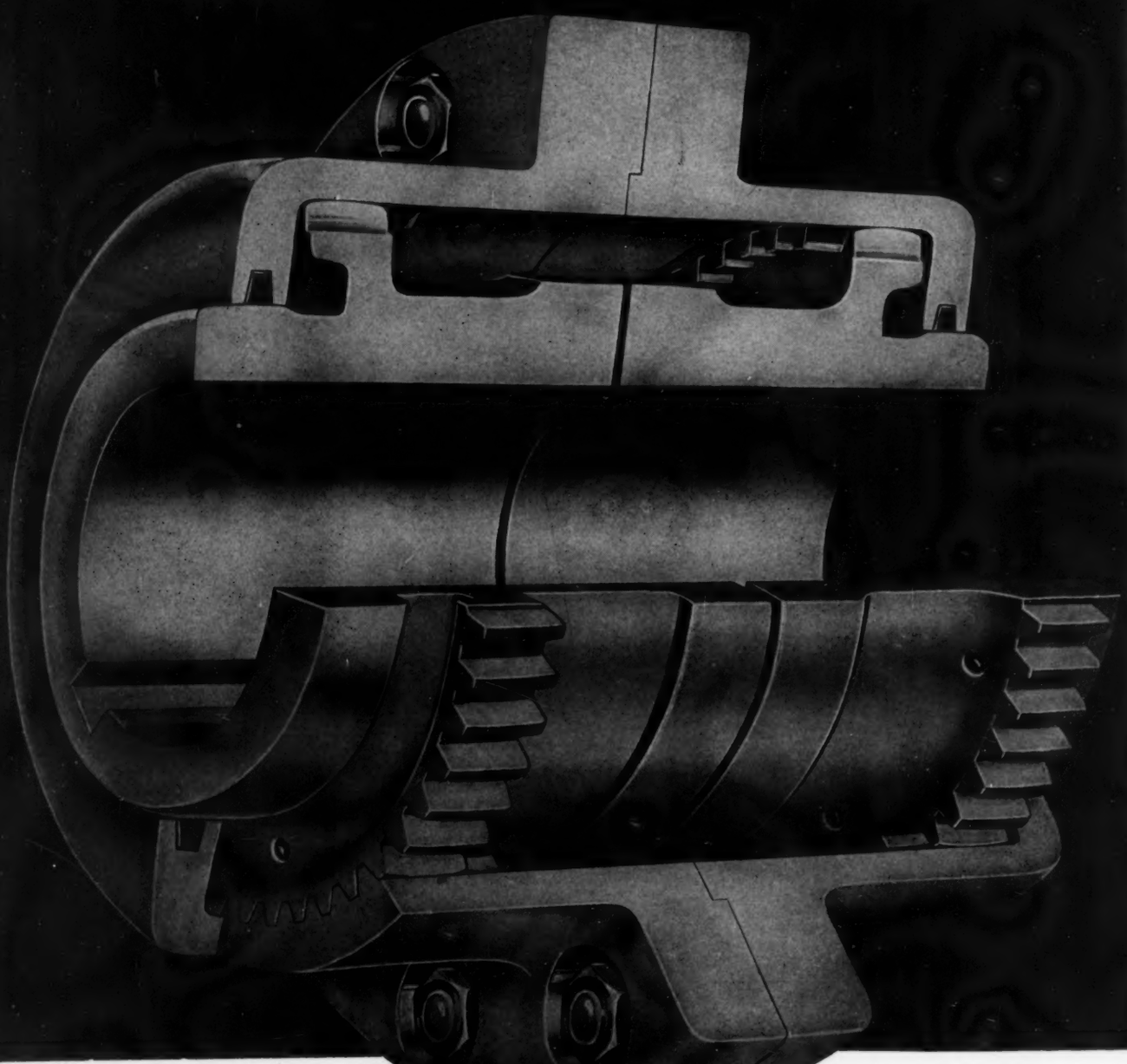
POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

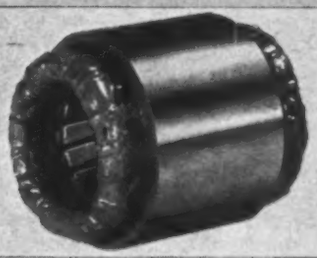
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

PG-4 PX-5 Synthite* 223

PG-4 A Clear Baking Varnish with excellent oil resistance. Thermosetting and possessing a high dielectric strength, this varnish can be thinned with VM&P Naphtha (Benzine) and does not require any special solvent.



PX-5 A Black Baking Varnish adaptable to all types of electrical units, suitable for Formvar, Formex and glass coated wire. Degree of hardness can be regulated by the baking time.

223 A Clear Baking Varnish which provides exceptional bonding properties and heat resistance, making it ideally suited for high speed windings. The hardness of this material permits ease in machining.

Synthite* . . . a trade name that is gaining more and more recognition throughout the electrical industry, can be furnished in both air drying and baking type varnishes, all formulated to give you more uniform and efficient production. These polymerizing types of varnishes provide a heavier build-up than most conventional grades, affording a high degree of resistance to oil, water, acids and alkalies. There is a grade of DOLPH'S SYNTHITE that will do a better insulating job for you.

Write us today for further information and let our Laboratory and Service Engineers assist you in your insulating varnish problems, without any obligation on your part.

* REG. U. S. PAT. OFF.

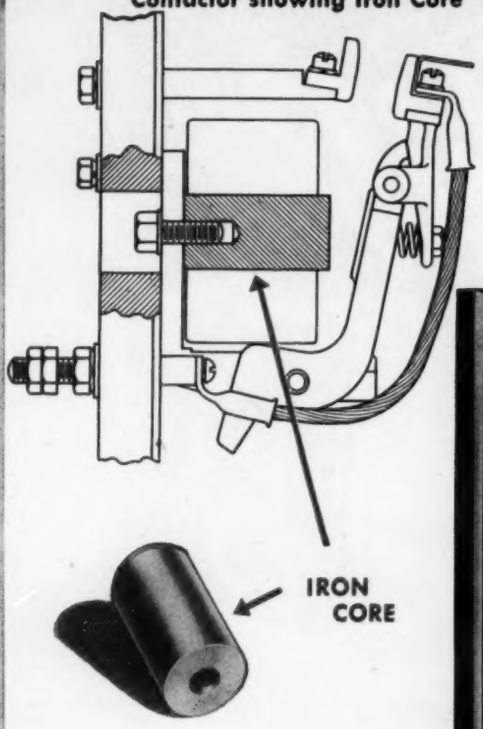
Insulating Dolph's *Varnish Specialists*

JOHN C. DOLPH COMPANY

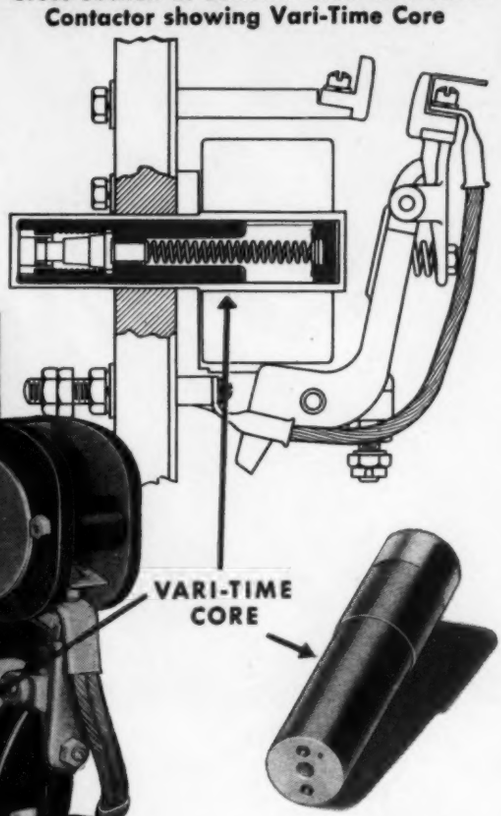
168 EMMETT STREET • NEWARK 5, N. J.

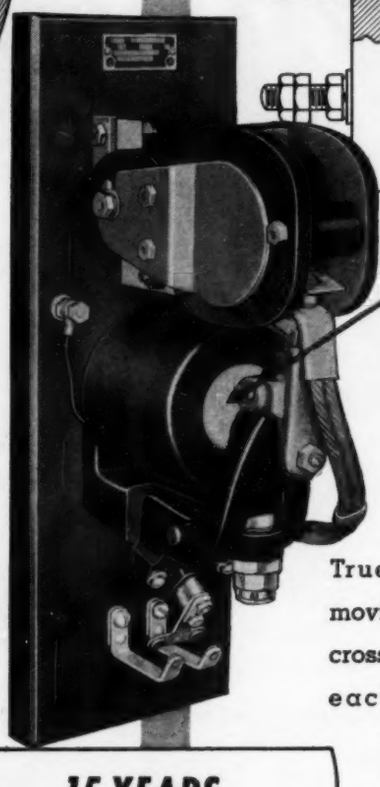
To your MAINTENANCE MAN the VARI-TIME CORE is a SOLID CORE... it has UNIT RESPONSIBILITY

Cross-Section of Bulletin 7400 Type RD Contactor showing Iron Core



Cross Section of Bulletin 7400 Vari-Time Contactor showing Vari-Time Core





You would not expect to have maintenance problems with the solid core shown above.

You might, however, expect to have maintenance problems with the mechanism of the "3C" Vari-Time Core.

But, built as the Vari-Time core is, you will have no more difficulty with it than you do with the iron core.

15 YEARS

of maintenance-free operation have established the stability of the Vari-Time Core, and have justified our guarantee:—"The Clark Controller Company will replace free of charge, any core which will fail in service during the lifetime of the controller."

True, the Vari-Time Core has moving parts as shown in above cross-section. At the same time each core is hermetically sealed in oil to establish its *unit responsibility*.

It is designed and built in sizes to suit required magnetic properties. Mechanically, it proves to be a giant for the work it has to do.

The Vari-Time Core provides completely reliable definite time delay for Bulletin 7400 DC Vari-Time Accelerating Contactors

ASK FOR FULLY DESCRIPTIVE BULLETIN 7400

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • CONTINUE TO ROLL WITH CLARK CONTROL

NEWS SUPPLEMENT

March, 1945

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

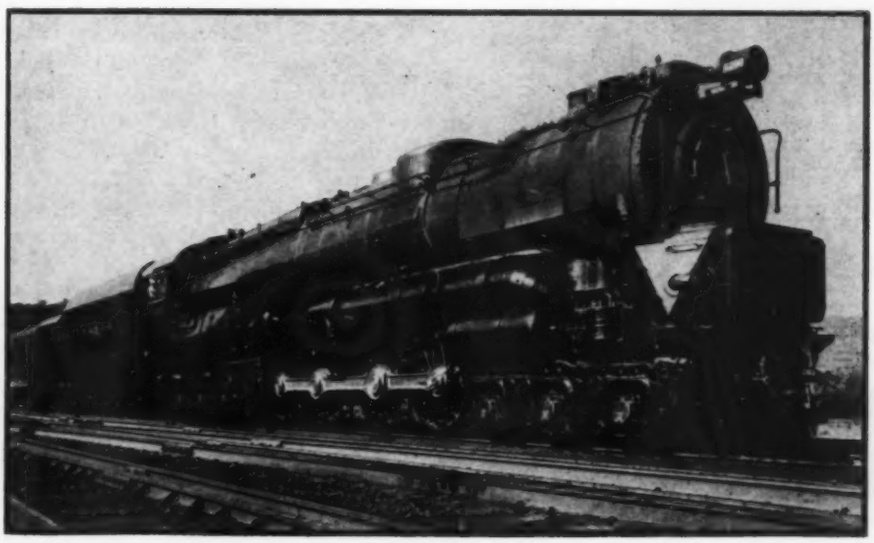
TURBINE DRIVEN LOCOMOTIVE OFFERS INCREASED POWER AND EFFICIENCY

▲ The most recent advance in railroad motive power, a geared turbine locomotive which is capable of producing 6900 shaft horsepower, has been developed by the Pennsylvania Railroad, the Westinghouse Electric and Manufacturing Company, and the Baldwin Locomotive Works.

Higher efficiency and smoother propulsion are the most important of several advantages the unit offers over the conventional reciprocating drive. Since power is applied evenly through the gears, the unbalanced forces inherent in a reciprocating engine are eliminated. An approximate 20 per cent increase in efficiency not only means a savings in fuel but, more important, greater power output from a locomotive of given dimensions.

Designed for fast, long-haul, passenger and freight service, the locomotive can operate at speeds up to 100 miles per hour. Two turbines — one for forward motion and one for reverse — are connected through double helical reduction gears to the middle two of the four driving wheels. The forward unit, which is composed of six stages, is always engaged with the main gear pinion; the reversing unit, a single stage Curtiss type, is connected only when the controls are in reverse. Steam pressure at boiler outlet is 310 pounds per square inch gauge and the temperature is 750 degrees F, which is common for modern locomotives. Stoker fired, the locomotive uses coal as fuel.

The forward turbine can be seen suspended from the frame between the middle two driving wheels. A smaller unit on the left side of the engine provides reverse power.



CHEMICAL PLANTS USE CARBON MATERIALS

▲ A perennial problem confronting materials engineers in chemical process industries has been that of finding inert, non-contaminating construction materials that would operate effectively under both acid and alkaline conditions, and where strong organic solvents are present.

Calco Chemical Division of the American Cyanamid Company has made available information on its extensive utilization of "Karbate" materials, which indicates the versatility of the materials and their suitability for a variety of chemical applications. Calco conducted laboratory and pilot plant tests over an extended period of time with all available chemical construction materials, such as metals, ceramics, chemical brick and "Karbate" to determine the most suitable material. On the basis of these tests. "Karbate" units were picked and trial plant installations made.

One of the first plant installations was the lining of a steel scrubber in which sodium hydroxide and sulphuric acid were used alternately to remove some of the impurities from crude organic raw materials required in the processing of dyestuffs and intermediates. Previously, the operation had been carried out in a brick-lined tower. Due to the action of the caustic solution, the brickwork washed away at a rate that made it necessary to reline the tower at 12 to 18-month intervals. The joints in particular were a constant source of trouble, as it was necessary to "point up" the cement quite frequently.

Although "Karbate" brick was somewhat more expensive than the chemical brick, total installation costs were approximately the same for both types of lining. This was due to the machinability of the "Karbate" materials which permitted the lower part of the cone-shaped tower to be formed of machined slabs which were then set in place in a fraction of the time required to lay the bricks in place.

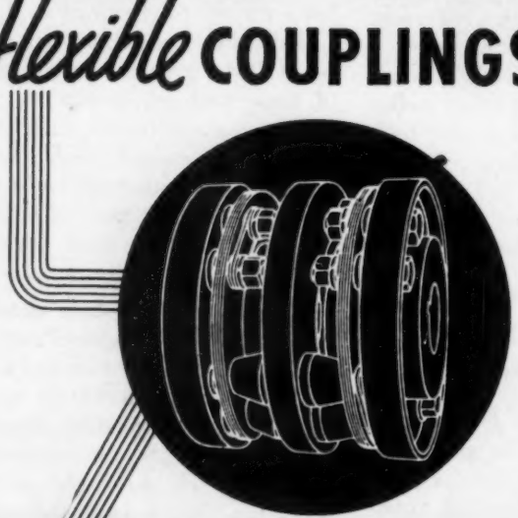
A further and more important economy was realized after the installation in terms of uninterrupted service with

negligible maintenance. The unit has now been in constant service for four years, or from two to four times as long as the chemical brick linings, and still shows no sign of scoring or deterioration.

The carbon graphite materials were utilized to cope with a chlorination problem in which refluxed vapors containing muriatic acid caused severe corrosion in the piping and condensers of the process equipment. In this operation, it is necessary that the process equipment remain inert under the condensing muriatic acid and the organic solvents present and maintain a stable coefficient of heat transfer. The material used must also be impervious. The new equipment remained completely free from corrosion scale formation and was unaffected by HCL at any temperature or concentration encountered.

At the present time, this equipment has been in operation for approximately five years and is functioning as well today as when installed. It has neither corroded nor eroded to a detectable extent in that time.

THOMAS
Flexible COUPLINGS



TYPE DBZ
TYPE DSM
TYPE CM
TYPE AM
TYPE-MT
TYPE SS

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required

TYPE DBZ-D

WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

NEW ELECTRODE INCREASES ARC-WELDING PRODUCTION

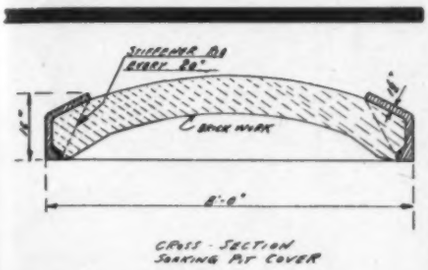
▲ A new heavily covered arc-welding electrode for flat and horizontal fillet welding as well as for flat butt welding has been announced by the Electric Welding Division of the General Electric Company. Desirable wherever weld requirements include high mechanical properties, rigid X-ray examination, good profile, high deposition rate, and good surface appearance, the applications of this electrode include pressure vessels and pertinent connections, heavy machine bases, and structural parts such as column plates, columns, roof trusses, beams, and girders where the thickness of the section permits.

Known as type W-27, the new electrode is characterized by an exceptionally high melting rate which results in increased production and higher speeds at the same welding current as other electrodes. At comparable production speeds, type W-27 requires less heat input to the joint, thus reducing warpage and internal cooling stresses. These features, plus its ability to operate through a wide range of current, and freedom from undercut, suggest the use of type W-27 for a great many war production tasks.

Readily recognized by its steady, forceful, spray-type arc, the new electrode operates on alternating current or direct current with either straight or reverse polarity. It has low spatter loss and easy slag removal and produces welds of excellent appearance.

ALLOY CASTINGS USED IN PIT COVER FABRICATION

▲ Wartime necessity has forced many radical changes in engineering thinking involving the possible success of unusual applications for high duty iron castings. A typical example of this is found in a new application for Meehanite castings in the construction of soaking pit covers. Having been in service more than a year it is possible to evaluate the success of the application.



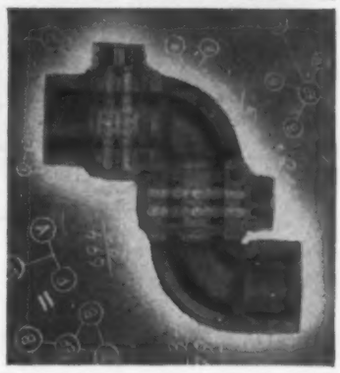
Ten of these covers, 13 ft x 8 ft, have been in service more than a year.

Normal soaking pit cover design calls for steel castings which at the time could not be secured. As a matter of necessity engineers decided to construct the pit covers from Meehanite castings for the side beams, end beams and the center brace. Overall dimensions of the covers were 13 ft x 8 ft (see sketch). Ten complete covers were cast and eight put into immediate service. In addition, during construction of the furnaces the base plates upon which they were supported were also cast in Meehanite.

NEW COKE OVENS FOR INDIANAPOLIS

▲ The Wilputte Coke Oven Corporation, 40 Rector Street, New York, has been awarded a contract by Citizens Gas and Coke Utility, Indianapolis, Indiana, for the construction of a battery of 47 Wilputte underjet, high-and-low burner coke ovens and auxiliary equipment. The ovens will be equipped with Wilputte standard self-sealing doors and hydraulic door handling machines and will be designed to be underfired with either coke oven gas or producer gas. Included with the auxiliaries will be a gas producer plant which will include three 10 foot Semet-Solvay automatic gas producers, waste heat boilers and conditioning equipment.

CHIKSAN FORMULA FOR A PERFECT SWIVEL JOINT...



$BB_2 + EP = \frac{LT}{P/V}$

BB_2 = **Double rows of Ball Bearings** — For easy turning with minimum friction. They also maintain perfect alignment of moving parts.

EP = **Effective Pack-Off** — This self-adjusting unit permits the use of the same Swivel Joint for all services. Nothing to tighten or adjust.

LT = **Low Torque** — No excessive friction drag because turning takes place on ball bearings which hold moving members together. Tightness of Joint does not depend upon compressing packing element by means of bolted flanges, thereby causing joint to stick.

P/V = **Pressure or Vacuum** — Pre-determined pressure on Packing Ring prevents leaks due to pressure or vacuum. Packing automatically adjusts itself to either service.

These are the essential elements for perfect swivel action. You get ALL of them when you specify Chiksan Ball-Bearing Swivel Joints.

WRITE FOR CATALOG AND ENGINEERING DATA

CHIKSAN TOOL COMPANY
Ball Bearing SWIVEL JOINTS for ALL PURPOSES
BREA, CALIFORNIA

How To Be an "ESOFHMBP"*

*Expert Solver of Fractional Horsepower Motor Brush Problems

FIRST you build, staff and equip a complete laboratory for the purpose. Next, make available to it all the experience and knowledge gained from a half century of brush manufacturing. Then, we believe, you can give our type of brush testing service.

Others, it seems, agree. For more and more electric motor manufacturers are submitting their *present* and *postwar* models to our Fractional Horsepower Motor Brush Testing Laboratory for brush recommendations.

Thanks to recent improvements in our manufacturing facilities and methods, speedier deliveries of "National" brushes are now being made. And helping to speed deliveries is this modern laboratory which enables National Carbon Company to recommend brush grades more promptly and accurately than ever before.

We urge you to get in touch with our nearest Division Office for full information on how to submit motors for brush testing under *your own* specified load, temperature, humidity, altitude or other conditions.

The word "National" is a registered trade-mark of National Carbon Company, Inc.

KEEP YOUR EYE ON THE INFANTRY . . .
THE DOUGHBOY DOES IT!

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
General Offices: 30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IMPROVEMENTS MADE IN RADIATION PYROMETERS

▲ Five major improvements, just introduced in Radiamatics, will make this compensated radiation pyrometer secure against air and gases up to one pound per square inch gauge pressure at temperatures up to 250 F, it is announced by the Brown Instrument Company, Philadelphia.

The five improvements are: 1. Use of an adhesive sealing compound between the lens and mounting ring; 2. Use of brass for lens retaining and mounting rings; 3. Controlled torque is applied when assembling the lens retaining and mounting rings; 4. Two spanner wrench holes in the lens mounting ring face have been replaced with a milled slot which avoids cutting through the ring face, and, 5. Use of a more positive sealing, with an improved adhesive, of the sighting glass located in the rear of the thermopile assembly.

Other improvements include use of aluminum instead of cast iron for the Radiamatic housing. This latter development applies to all Radiamatics shipped after March 1.

The Radiamatic, product of the Brown division of Minneapolis-Honeywell Regulator Company, is designed primarily to meet exacting demands of steel mills, metallurgical works, ceramic plants and related industries. It consists essentially of a heat resisting lens, a compensator and a thermopile. Energy radiated from the hot object being measured falls on the lens and is focused on the thermopile which generates an e.m.f. proportional to the object's temperature. The measurements are independent of ambient temperatures.

LONG MATERIAL HANDLED BY TRUCK WITH AUXILIARY

▲ In the manufacture of landing mat strips the handling and transportation of large unit loads by electric industrial trucks presented difficulties due to the ungainly dimensions of the material. Aisles were not wide enough to permit carrying the strips crosswise of the platform, and the standard platform was not long enough to permit carrying them lengthwise and have a well balanced load. A wholly satisfactory solution was obtained by constructing an auxiliary dolly mounted on casters, which can be moved about manually to a limited degree and can also be transported rapidly between various operating departments by the electric truck.

The dolly was made by welding flame-cut parts of standard flat rolled shapes. A steel fitting bolted to the forward end of an Elwell-Parker power truck platform provides for a pin connection between the base frame and the truck. The truck lifts only one end of the dolly and can either push or pull the load through narrow aisles and around corners with ease and safety.

This arrangement for handling loads of long pieces has the advantage that the truck can be made quickly available for handling other types of loads on skids in the same plant. Although designed especially for handling landing mat strips, the superstructure can easily be modified to accommodate other types of material in long lengths such as tubes, bars, small trusses and the like.

For better steel . . and more of it
this recorder of facts helps control STEEL QUALITY
YOU find Hays Series "OT" Pressure Recorders on many new and modernized open hearth installations—and for just one purpose: to make a permanent record of furnace performance. Guesswork is eliminated, man power saved, and rejects cut to the minimum.
On the 10-inch 24-hour charts you can have a record of two draft values, two pressure values, two differential values or any combination of two of those three values.
Here's a simple practical means to more effective control of steel quality. Better get the facts about it—send for Bulletin 43-586.
The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

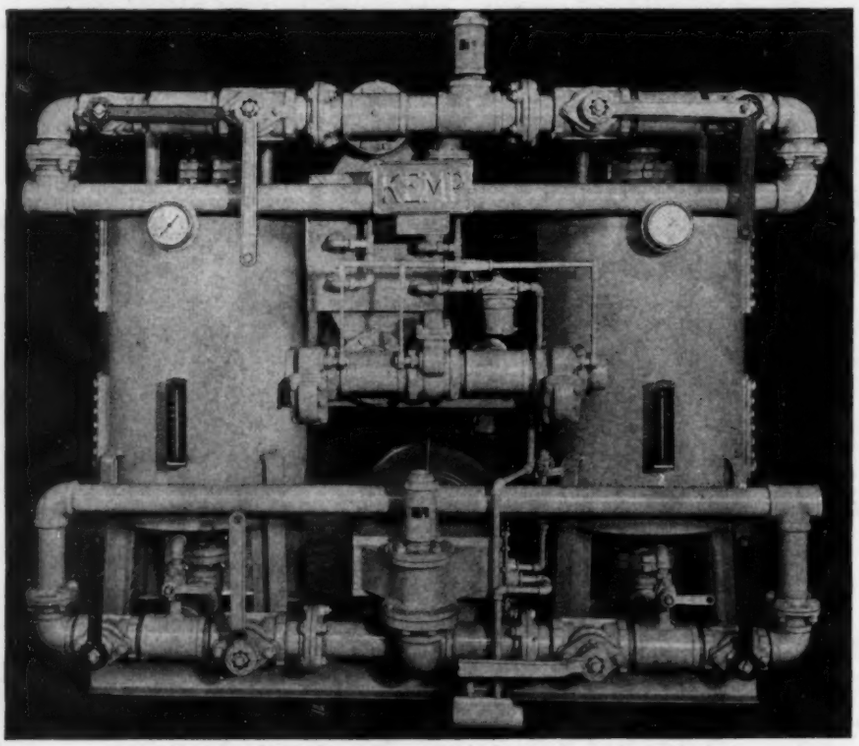
MACHINE MANUFACTURER EXPANDS SALES OUTLETS

▲ Launching a greatly expanded sales and service program, Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania, has announced the appointment of sales agencies in 16 major cities to handle Thomas equipment for all of the United States—east of the Mississippi River. Similar agencies for territory west of the Mississippi will be announced shortly.

Purpose of the program is to provide complete distribution for Thomas equipment, and eventually service for machinery after installation, in all important industrial areas, George P. Thomas president of the company, states.

The program has been developed during the past six months by Charles H. Slaughter, sales manager for Thomas.

The agents are: General Machinery Corporation, Boston, Mass.; Giebel, Inc., New York, New York and New Haven, Connecticut; C. H. Briggs MachineTool Company, Syracuse, New York; W. W. Wentz, Rochester, New York; J. L. Osgood Machinery and Tool Company, Buffalo, New York; The L. A. Benson Company, Baltimore, Maryland; Smith Courtney Company, Richmond, Virginia.; Chandler Machinery Company, Atlanta, Georgia; George D. Miller Company, Cleveland, Ohio; Brokaw Machinery Company, Cincinnati, Ohio; Joseph Monahan, Grand Rapids, Michigan; Bryant Machinery and Engineering Company, Chicago, Illinois; Quinn and Quinn, Birmingham, Alabama; Noland Company, Chattanooga, Tennessee; Frederic and Baker, Shreveport and New Orleans, Louisiana.



High Efficiency! **SUB-ZERO DEW POINTS @ 1/4¢/Mcf**

Compressed air or gases may be DRIED to sub-zero dew points at surprisingly low cost in **efficient** Kemp Adsorptive Dryers—in many cases, the total costs, including amortization, run as low as ¼ of a cent per 1,000 cubic feet (Mcf) DRIED.

Compressed air for your plant probably costs you 6c to 10c per Mcf. Why not spend a fraction of a cent more and get full value from it? DRIED compressed air eliminates corrosion and rusting . . . prevents clogged orifices . . . does away with frozen air-lines and wastage from "blowing" . . . permits accurate instrumentation and continuity of processing . . . saves man power by reducing maintenance and trouble shooting . . .

Reduce operating costs and increase over-all plant efficiency with **efficient** Kemp Adsorptive Dryers.

Ask For Bulletin 25-CA

OTHER KEMP PRODUCTS

Nitrogen Generators • Inert Gas Producers
Atmos-Gas Producers • Immersion Heaters
Flame Arrestors for vapor lines, flares, etc.
The Industrial Carburetor for premixing gases
Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks.

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore-2, Maryland.

KEMP of BALTIMORE

PORTABLE UNIT FOR TEMPORARY HEATING

▲ This "Janitrol" portable heater proves an effective heating plant for a warehouse in an emergency, although it was designed for preheating of airplanes and for warming maintenance crews at Arctic air bases. Spot heating of buildings where temporary heat is needed or where the regular plant becomes inoperative are some of the new applications for this wartime aviation development, according to Surface Combustion, manufacturer of the unit, with plants in Toledo and Columbus, Ohio. The heater pictured

also thaws out cargo holds of ships, warms boxcars carrying perishables, thaws railroad switches and other jobs. The heater burns gasoline, kerosene or light oil, including diesel oil,

and has an output of 250,000 Btu per hour. Its heat rise of 230 degrees enables it to deliver positive heat in sub-zero temperatures. It can be wheeled or pulled sled-fashion to the job, the manufacturer reports.

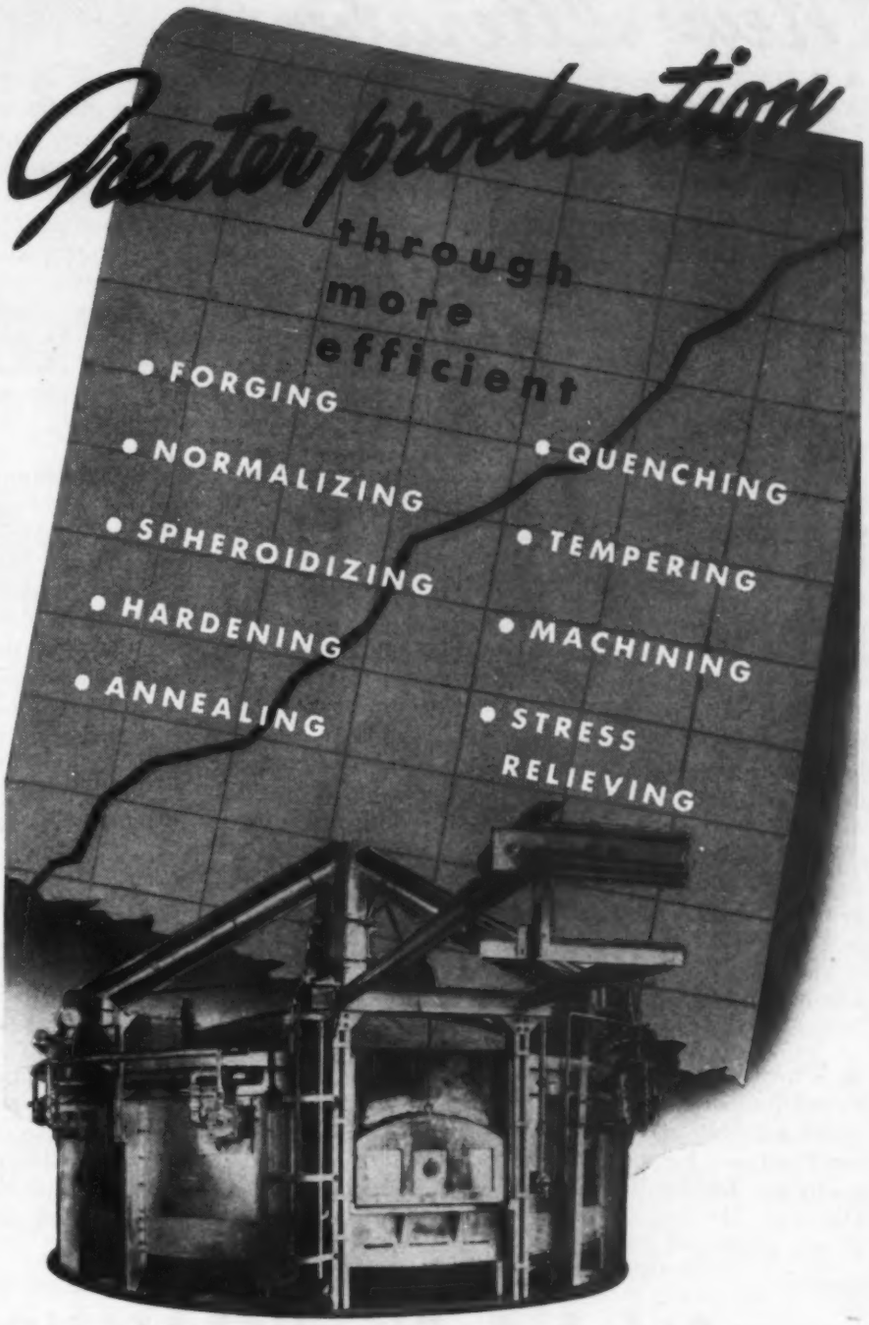
KAISER ORGANIZES FIRM FOR ENGINEERING WORK

▲ Engineers long associated with Henry J. Kaiser, and responsible for the design and construction of some outstanding projects, have been organized as a permanent group known as Kaiser Engineers, with headquarters in the Kaiser Building, Oakland, California. This move will make available to others the engineering talent which has been responsible for the design of many of the Kaiser projects.

Henry J. Kaiser is president of the new organization, with E. E. Trefethen, Jr., vice president; T. M. Price, vice president; and George Havas, vice president and general manager. It is the announced policy of the company to undertake engineering work in any part of the world. The organization is well-rounded and includes qualified engineers in all of the major fields of engineering — civil, hydraulic, structural, mechanical, electrical, architectural and metallurgical. An experienced staff is available for procurement of materials and equipment. Consulting engineers will be engaged as circumstances warrant. George W. Vreeland will serve as chief consulting engineer and George B. Scheer as chief consulting electrical engineer.

INTERNAL ELECTRODES HEAT DEEP SALT BATHS

▲ Two Ajax-Hultgren electric salt bath furnaces, recently installed in a large mid-western plant for isothermal heat treatment of special ordnance parts, represent the deepest salt baths constructed to date. These furnaces have a salt depth of 7 feet. Both furnaces, austenizing and quenching, are internally heated by closely spaced electrodes — an exclusive design principle of the Ajax Electric Company, Inc., Philadelphia, Pennsylvania. Large baths of this kind are made practical only by internal heating, since localized overheating and premature pot failures are eliminated.



★ Tate-Jones Rotary Forging Furnaces have been in continuous operation for periods up to 3 years without shutdown for major repairs. Do your furnaces equal this performance? Ask for comparative operating costs. Tate-Jones and Co., Inc., P. O. Box 1016, Pittsburgh 30, Pennsylvania.

Send for your copy of the new Tate-Jones Catalog.

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Gas and Oil Fired • Pusher • Variable Speed Conveyor • Rotating Hearth • Car Bottom • Roll Down • Horizontal and Vertical Pit • Circular and Rectangular Pot Furnaces • Oil, Gas and Combination Burners • Steel Fabricators.

ESTABLISHED 1898

Equipment for Cycle Annealing • Austempering • Martempering • Pyrostlizing

New Literature

▲ Ingersoll-Rand announces the publication of the following bulletins: "Air-Operated Tools for Maintenance, Construction, Demolition" (Form 117) shows at a glance the line of I-R air tools and portable compressors available for speeding up work. A number of excellent photographs illustrate air tools on construction, demolition and plant maintenance jobs. Several of these show new uses for well-known tools.

"Barometric Condensers" (Form 9012) covers both the disc-flow and ejector-jet types, explaining the uses, advantages and operation of each. Several schematic diagrams illustrate how these vacuum-producing systems work and a number of photographs show the condensers in various industries such as chemical, fertilizer, sugar and power plants.

"Steam-Jet Ejectors" (Form 9013) covers the operating characteristics, principles, and features of the company's vacuum-producing equipment, as well as construction details and schematic diagrams of various single and multi-stage set-ups, with and without intercondensers, precoolers and after-condensers.

These bulletins may be obtained by writing Ingersoll-Rand Company, 11 Broadway, New York 4, New York.

▲ A new protected-type motor, designed for both drip-proof and open motor applications, is illustrated and described in a four-page bulletin just published by the Crocker-Wheeler Division of Joshua Hendy Iron Works at Ampere, New Jersey.

Among the features of this many-purpose motor which are illustrated are the centrifugal bearing seals, Alucast rotor, vinyl acetal protected windings, and the internally-shielded, partially-enclosed frames and shields which prevent metal chips, dripping liquid and other foreign matter from entering the motor. Principal applications are pointed out in the text and illustrations. Copies of this bulletin may be obtained by writing to the company.

▲ A new catalog entitled "Insulating Varnishes and Compounds" has been issued by John C. Dolph Company, Newark (5), New Jersey.

This 56 page informative booklet contains many helpful tables, charts and articles, all compiled for the purpose of providing a worthwhile approach to any insulating varnish problem. It is a handy, ready reference for many problems, such as the selection of insulating varnishes and compounds, thinning of insulating varnishes, etc.

▲ The Automatic Transportation Company, Division of The Yale and Towne Manufacturing Company, manufacturers of electric industrial trucks, 101 West Eighty-seventh Street, Chicago 20, is now preparing its 1945 series of materials handling bulletins, No. 1 to 10.

Each bulletin consists of four to six pages of pictures and text dealing with actual operating methods, and is based on plant interviews and the study of methods.

The bulletins are useful to manufacturers and distributors in all lines of business, and particularly to many who are planning postwar operations. They are part of a continuing series begun in 1941. Earlier bulletins provided technical information for the armed forces prior to preparation of their own warehousing and material-handling manuals. The new 1945 series is well diversified.

Bulletins in the new series will be sent periodically, three or four at a time, without charge, to business firms, by writing Edwin L. Bertram, manager sales promotion, at the above address.

▲ Advantages of dual-fuel burning systems are graphically emphasized in a full color bulletin issued by the North American Manufacturing Company, 2910 East 75th Street, Cleveland 4, Ohio. Detailed drawing shows installation and operating features of typical installation. The system uses any fuel oil or gas of 500 Btu and higher; it is possible to change fuels without changing piping or burner inserts; exact fuel-air proportions automatically maintained at all size fires; no steam or compressed air is required; burns both gas and oil at same time with automatic proportioning; one air valve controls amount of fire, either gas or oil.

▲ A six-page folder on their low temperature welding rods has been issued by Eutectic Welding Alloys Company, 40 Worth Street, New York, New York. For plants and their welders, the new folder describes Eutetics's exclusive procedures fully, in which their rods, applied at low temperatures to cast iron, steel,

A. I. S. E. DISTRICT SECTION MEETINGS

BIRMINGHAM, APRIL 30, 1945

"Engineering Principles of Induction Heating," by N. R. Stansel, Industrial Engineering Department, General Electric Company, Schenectady, New York.

BUFFALO — TUESDAY, APRIL 10, 1945

"Steel Mill Maintenance," by D. W. McLean, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada. (This meeting will be held at Hotel General Brock, Niagara Falls, Ontario, Canada.)

CHICAGO — TUESDAY, APRIL 3, 1945

"Building a Steel Mill During War Time," by George McKee, General Master Mechanic, Republic Steel Corporation, Chicago, Illinois.

"Organization of a Lubrication Department," by Charles Bailey, Chief Lubrication Engineer, Gary Steel Works, Carnegie-Illinois Steel Corporation, Gary, Indiana.

"Steel Plant Welding," by Walter K. Simon, General Foreman, Weld Shop, South Works, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

DETROIT — TUESDAY, APRIL 10, 1945

"The Flash Welding of Alloy Steels," by J. C. Barrett, Metallurgist, The Taylor-Winfield Corporation, Warren Ohio.

PHILADELPHIA — SATURDAY, APRIL 7, 1945

"Cleaning Open Hearth Flues by Vacuum," by A. F. Franz, General Superintendent, Steel Division, Alan Wood Steel Company, Conshohocken, Pennsylvania.

"Production and Maintenance Instruments," by Clyde S. Cassels, Mechanical Engineer, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania.

"Steel Plant Refractories Performance Records," by M. A. Fay, Ceramic Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

PITTSBURGH — MONDAY, APRIL 9, 1945

"The Storage and Handling of Lubricants," by L. E. Lovitt, Lubricating Engineer, Socony-Vacuum Oil Company, Inc., Pittsburgh, Pennsylvania.

"Water Supply," by C. D. Foight, Design Engineer, Carnegie-Illinois Steel Corporation, Homestead, Pennsylvania.

"An Improved Design of Commutators," by Paul McKeever, Electrical Engineer, American Rolling Mill Company, Butler, Pennsylvania.

The new Philco "Thirty", with 30% longer life, is identified by its distinctive red top.

Consistently through the years, users of PHILCO Storage Batteries—both motive power and stationary types—have been *first* to get the major developments contributing to high capacity, greater efficiency, longer life, lower cost. Newest Philco *first* in industrial storage battery engineering is the new Philco "Thirty" with *30% longer life*—now available in certain types and limited quantities for electric industrial trucks. Catalogs of this and other modern Philco Batteries for your special needs will gladly be sent on request.

Philco Corporation, *Storage Battery Division,* Trenton 7, New Jersey

For 50 years a leader in Industrial Storage Battery Development

Flexibility of movement

with Schloemann "motor-rollers"

Each Schloemann "Motor-Roller" is individually powered by a squirrel cage motor, housed in a free turning shell on anti-friction bearings, assuring flexibility of movement.

In addition to flexibility, this simplification of design lowers operating and maintenance expenses on shear, scale or mill tables. The stator has no electrical connection to the rotor and represents the simplest piece of apparatus for converting electrical energy into mechanical work. The free turning shell permits each "Motor-Roller" to act as an idler roller when the current supply is disconnected.

Schloemann engineers are available to discuss with you your "Motor-Roller" needs.

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aluminum, bronze, etc. produce clean, strong bonds yet leave the welded part easily machinable. The strength of the machined part is unimpaired and no distortion has occurred, a very important consideration in repair work. There are many suggestions for salvaging parts which were thought ready for the junk pile and putting them to work again.

▲ Bulletin CC-5M-145 is an eight page leaflet dealing with a.c.f. full pipe-area lubricated plug valves. Various types and sizes of the valves are listed, and information is given on their application and maintenance. Copy on request to the American Car and Foundry Company, Valve Department, 30 Church Street, New York, New York.

▲ Cochrane Corporation, Philadelphia, Pennsylvania, have available an informative publication on Green Sand Zeolite Softeners. Power plant operators, or those interested in the production of soft water, can obtain this informative booklet by writing for Publication 2860-A.

▲ A new Murex wall chart, which serves as a useful guide in selecting the proper electrodes for individual welding jobs, contains a list of Murex electrodes divided into four groups for quick reference, including (1) mild steel, (2) special steels, (3) stainless steels, and (4) hard surfacing. The electrodes are described according to AWS-ASTM class, with color identification, recommended current strengths, polarity, and physical properties. There are also brief descriptions of the general characteristics of the Murex electrodes and their applications. Copies will be sent without charge at request upon company letterhead to Metal and Thermit Corporation, 120 Broadway, New York, New York.

▲ "The Modern Gas Turbine," by R. Tom Sawyer, is an authoritative treatise on the gas turbine as a supercharger and as a prime mover. The text is fundamental in that highly mathematical calculations have been omitted, but sufficient theory is given to suit the needs of most engineers and executives. The book includes the history, fundamentals, calculations, and applications of gas turbines in diesel practice, in industry, in marine service, in locomotives and in aircraft. A short discussion of jet propulsion is also included. Published by

Prentice-Hall, Inc., New York, New York, $4.50, 216 pages.

▲ "Aluminum," by N. H. Engle, H. E. Gregory and Robert Mosse, is not a technical treatise of production processes but rather an industrial marketing appraisal. Sponsored by the Bureau of Business Research of the University of Washington, the book surveys bauxite resources and other materials, as well as discussing electric energy, labor requirements and the capital and management set-up of the aluminum industry. Markets, both past and prospective, are analyzed. The book contains much in the way of statistics, including some actual operating costs. Published by Richard D. Irwin, Inc., Chicago, Illinois, $6.00, 494 pages.

▲ "Electric Power Distribution for Industrial Plants" is a report outlining sound engineering principles of distributing power in industrial establishments. It analyzes service requirements, voltage regulation problems, load characteristics and distribution system characteristics, and deals with the selection of equipment for distribution systems. Published by the American Institute of Electrical Engineers, 33 West 39th Street, New York, New York, $1.00.

▲ The publication of two sets of abstracts or short descriptions of 45,000 alien owned U. S. patents seized by the Alien Property Custodian of the United States Government has just been announced by James E. Markham, the Custodian.

To help find items of particular interest, the abstracts have been classified and indexed. The mechanical and electrical abstracts (about 37,000 patents) consist of a short description and an illustrative drawing. The chemical abstracts (about 8000 patents) consist of a condensed description of the chemical principle involved.

The set of the mechanical and electrical abstracts is bound in four volumes comprising approximately 4,000 pages and includes a 48 page index. The set of chemical abstracts in 33 sections, contains about 2,000 pages and has a 400 page index. Each set of abstracts sells for $25 and may be obtained from the Office of Alien Property Custodian, 311 Field Building, Chicago 3, Illinois.

If the complete sets of abstracts are not desired, portions of them (sections or classes dealing with any one subject) are obtainable at proportional cost. An index showing the section or class titles and prices may be obtained free of charge by writing to the Alien Property Custodian, 311 Field Building, Chicago 3, Illinois.

▲ A catalog published by Silent Hoist and Crane Company, Brooklyn (20), New York, gives specifications for the various models of KraneKars, mobile swing boom cranes which have received wide application in the steel plants, as well as in other industries. Operated by a gasoline engine and running either on roads or rails, these units are used in a wide variety of industrial jobs. A copy of catalog No. 58 may be obtained upon request.

▲ A condensed bulletin covering Wing forced draft blowers, both turbine driven and motor driven, and Wing auxiliary turbines, has been issued by L. J. Wing Manufacturing Company, of New York. Information includes photographs of installations, capacity curves, dimension tables and operating data.

Type WMK Enclosed Safety Switch

CONDULETS

are **rain-tight.** You can use them in **both** indoor and outdoor non-hazardous locations. Also suitable for Classes III and IV hazardous locations. (NEMA Types 3 and 5)

Feraloy cases. Strong and durable. Four sturdy mounting feet. Many possible conduit arrangements for both horizontal and vertical through feed.

Safety. Positive interlock prevents opening the case unless switch is "off." Dead front switch held in "off" position while case is open.

Padlocks.
1. Cover may be padlocked to prevent unauthorized entry.
2. Operating handle may be padlocked "on" or "off."

Threaded operating shaft. Bearings permanently lubricated. Resists corrosion. Prevents the entrance of dust and moisture.

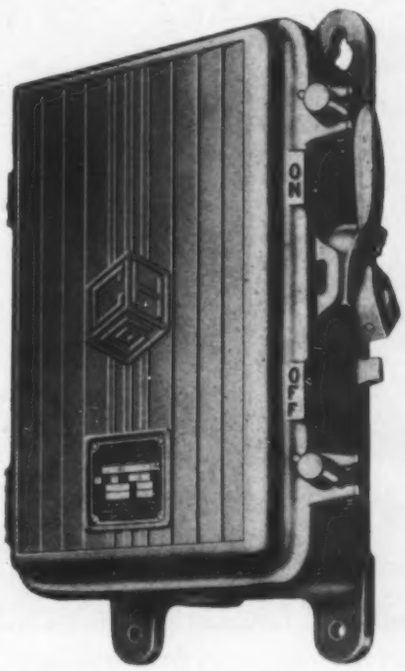
Switches. Quick make and break mechanism. Double break, reinforced, positive pressure-type blade and jaw construction. Positive pressure fuse clips. Combination solder or solderless wire lugs.

30, 60, 100 or 200-Ampere.
1 to 50-H.P

125 to 600-volt, A. C.

2 or 3-pole, fusible or fuseless.

Listed in Condulet Catalog No. 2500, Section 50, Page 20A.



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BUILT BY MORGAN *Engineering*

ONE OF TWO MORGAN 200-TON, 63'9" SPAN UNIVERSAL TYPE INGOT STRIPPERS IN A MID-WESTERN ELECTRIC FURNACE STEEL PLANT

The Stripper as illustrated will perform three distinct stripping operations without change in the stripping unit.

(1) Strip small-end-up or standard ingots.
(2) Strip big-end-up hot top ingots.
(3) Break small-end-up ingots loose from stools.

With this type of Stripper it is possible to strip a mixed heat without lost time.

Additional Morgan equipment in this plant includes: Two 300-Ton, 65'0" Span Pouring Cranes. Three 150-Ton, 65'0" Span Pouring Cranes. Two 150-Ton, 80'3" Span Hot Metal Charging Cranes.

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ALLIANCE, OHIO. 1400 Oliver Building, Pittsburgh

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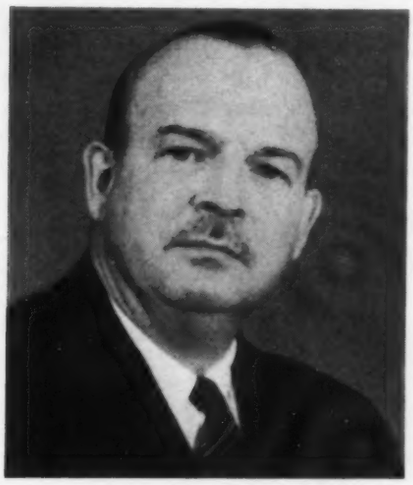
Personnel News

Robert S. Lynch, formerly with Republic Steel Corporation, has been appointed general superintendent of Atlantic Steel Company, Atlanta, Georgia.

Mr. Lynch began his steel career in the open hearth department of the American Steel and Wire Company at Vandergrift, Pennsylvania, and in 1924 joined the staff of the United Alloy Steel Corporation at Canton, Ohio. He was appointed assistant superintendent of the stainless steel department of Republic's Alloy Division in Massillon, Ohio in 1930, and in 1939 was appointed general superintendent of Republic's Canton-Massillon Enduro Division, in addition to being general superintendent of the Massillon Steel Division.



ROBERT S. LYNCH

Doing consulting work in 1944 for the Rigid-Tex Corporation in Buffalo, New York, Mr. Lynch was instrumental in developing a special rolled alloy which is being used in connection with a secret weapon in the South Pacific theater of war.

Robert M. Lang is now superintendent of blooming and billet mills in addition to his previous duties as superintendent of rod and bar mills of Atlantic Steel Company, Atlanta, Georgia.

A native Georgian, Mr. Lang entered the employ of Atlantic Steel Company as a helper in the carpenter shop shortly after graduation from Georgia School of Technology in 1915. Returning to Atlantic Steel in 1919 after his wartime service in the U. S. Navy, Mr. Lang progressed from various jobs in the plant until he was made superintendent of rod and bar mills in 1934.

Joseph H. Girdler was recently elevated from assistant superintendent to the position of superintendent of the open hearth department of Atlantic Steel Company, Atlanta, Georgia.

Mr. Girdler was born within earshot of Atlantic Steel Company's whistle, but in his boyhood moved with his parents, Mr. and Mrs. Tom M. Girdler, to Aliquippa, Pennsylvania. After attending Aliquippa's public schools, he graduated from Culver Military Academy and from Lehigh University.

In years immediately following his graduation, Mr. Girdler did oil exploration work in the southwest for Phillips Petroleum Corporation. He came to Atlantic Steel Company in 1941 in the open hearth department.

A. H. HJORTSBERG

Arthur H. Hjortsberg has been appointed assistant general superintendent of the Gary steel works, Carnegie-Illinois Steel Corporation, where a number of new promotions were announced. Mr. Hjortsberg has been serving as division superintendent of central rolling mills since February 1943. He is a native of Malmoe, Sweden, and educated in Sweden's School of Mining and Metallurgy. He began his American industrial career in 1924 with the Western Electric Company. In 1925 he became associated with Gary Works and advanced through various metallurgical and rolling mill positions.

Edwin H. Gott, former assistant division superintendent of maintenance has been promoted to assistant to general superintendent, in charge of service departments. He has been with Gary works since April 1941, starting as plant industrial engineer and then becoming assistant division superintendent of maintenance and in February 1943 became assistant division superintendent, central mills. He had previous experience with Carnegie-Illinois at Ohio works, Youngstown, Ohio, and at Clairton works, Pittsburgh, Pennsylvania. He is a graduate of Lehigh University and also took special courses at the University of Pittsburgh and Carnegie Institute of Technology.

John J. Golden, who has been serving as superintendent of the steel production division since 1940 is promoted to become division superintendent of the combined open hearths and central mills. He first became associated with Carnegie-Illinois in June 1911, working as an office boy in the South Chicago plant. He advanced through various positions at South works until October 1, 1935 when he became superintendent of the No. 2 open hearth shop. He held this position until

December 1938, when he was transferred to the Gary plant.

Raymond D. Dwyer was appointed superintendent of the plant's steel production department, while **Jacob C. Wilkins** was made superintendent of central mills. Mr. Dwyer has been associated with the plant since 1912 and his service has been in the open hearth shops. Since September 1943 he has served as assistant superintendent of steel production. Mr. Wilkins has been with the plant organization since 1910. He started as a billet mill foreman and advanced through various positions. His appointment to his new position followed 8 years as superintendent of the billet and 44 in. blooming mills, part of the central mills department.

T. W. Pettus has been appointed president of National Bearing Division, American Brake Shoe Company. Mr. Pettus has been executive vice president of the National Bearing Metals Corporation, until recently a subsidiary of the parent company. On December 6, 1944, the National Bearing Metals Corporation was merged with Brake Shoe and became a full fledged division.

John B. Fenstermacher has been appointed special sales representative of the Ohio Steel Foundry Company, handling principally the sale of rolling mill rolls and heat and corrosion resisting castings for that company on the Pacific Coast. Mr. Fenstermacher's office is in the Russ Building, San Francisco, California.

Malcolm E. Morgan has been named superintendent of the blast furnaces and coke works for the Southern District, Republic Steel Corporation. Mr. Morgan was born in Montgomery, Alabama, and received his early schooling there. His first job, after graduating in chemical and metallurgical engineering from Alabama Polytechnic Institute, was with the Tennessee Coal, Iron and Railroad Company in 1913 as a field chemist.

In 1918 he became chief chemist and metallurgist for Gulf States Steel Company and subsequently coke plant, blast furnace and open hearth superintendent for the company at Gadsden, Alabama, now part of Southern District of Republic Steel Corporation.

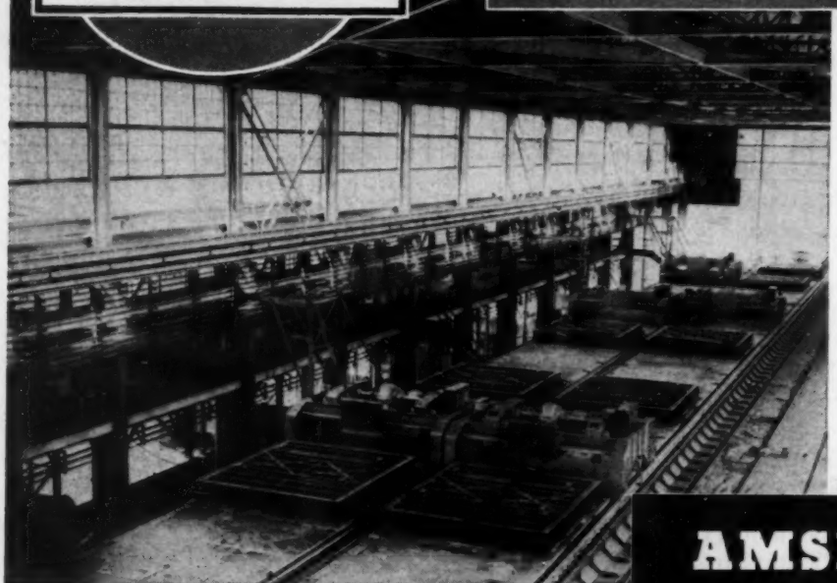
In 1940 Mr. Morgan was made superintendent of blast furnaces and coke works in the Youngstown District, returning to the South in 1943 as superintendent of blast furnace and coke works for the Gadsden plant. The present appointment puts him in charge of blast furnaces and coke works in both Birmingham and Gadsden.

John H. Lease has joined the staff of the Rees Machinery Company of Pittsburgh, Pennsylvania, to augment service to their customers in the tri-state area. An alumnus of the University of Cincinnati and of Northwestern University, Mr. Lease brings a wealth of experience gained in the planning and scheduling department of a prominent machine tool builder, and an intimate knowledge of the steel industry derived from his association with a large steel mill engineering firm.

Alton Parker Hall has been appointed general manager of sales of American Chain and Cable Company, Inc., with headquarters at 230 Park Avenue, New York. Mr. Hall joined the company about a year

AMCO

PIT FURNACES



Since their introduction in 1936 AMCO Recuperative Soaking Pit Furnaces have outsold all competitive designs. The reason . . . more and better heating with higher yields for less dollars, due in large part to the AMCO RECUPERATOR.

The Amco Recuperator will also accomplish similar results when applied to *large Amco Recuperative Rotating Hearth Furnaces.*

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A-1

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Hold that line!

A thought on peace-time business that helps war production

Stabilized, maximum employment is not only possible, it's essential if we are to maintain our American standard of living —and you can do something about it—*now.*

We Suggest This . . . (1) Determine your minimum needs to begin post-war business. (2) Place unrated orders for these necessary materials to be delivered when restrictions permit. (3) Advise your customers to follow this same plan.

Here's Why . . . (1) This plan permits *suppliers* to anticipate your needs and begin earlier production on them. (2) It also gives *you* a backlog to start you off when Uncle Sam cancels *his* orders. (3) Employees knowing of your activity in this respect will be more content and interested in their work—they'll feel more secure about your business offering peace-time jobs. (4) Your staff will be oriented in their thinking and less susceptible to vague reconversion worries.

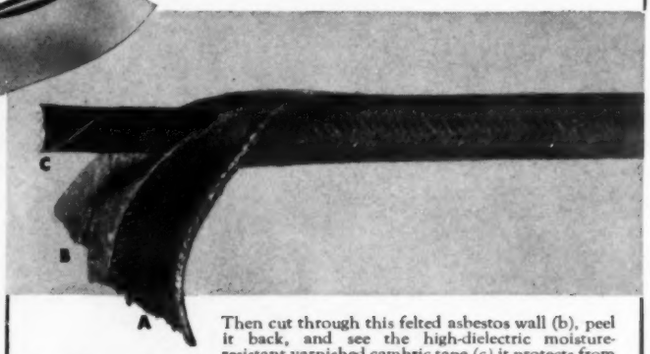
With all business following this plan, the gap will be shortened. Depleted world markets will be more *quickly* exploited. Those 55 million peace-time jobs needed for an ideal post-war economy will be much closer to actuality.

Remember . . . *Good* management always sees its responsibility to the overall national welfare. As C.E.D. reports, "the companies that are doing the best on war contracts are the same ones that are doing the best post-war planning." For reprints of this ad, write Heppenstall Company, Pittsburgh 1, Pennsylvania.

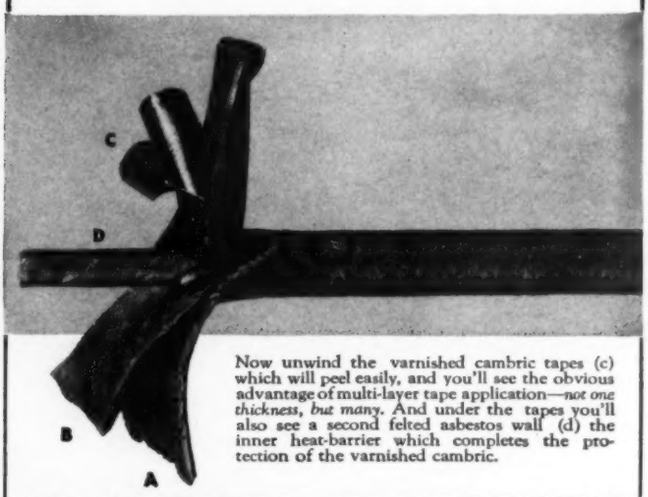
HEPPENSTALL, the most dependable name in forgings

Slit It Open and SEE the Difference

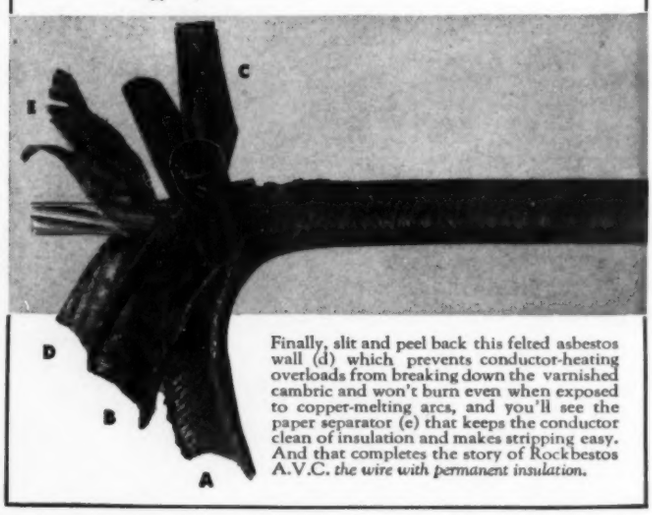
Take a sample of Rockbestos A.V.C. Power Cable, illustrated, or similarly insulated Motor Lead Cable, slit open the slick-finished heavy, heatproof, fireproof asbestos braid (a) which is resistant to moisture, oil and grease, and you'll find beneath a firewall of felted asbestos (b) a permanent heat-barrier against high ambient temperatures.



Then cut through this felted asbestos wall (b), peel it back, and see the high-dielectric moisture-resistant varnished cambric tape (c) it protects from heat, flame and oxidation. Notice too, the uniform coverage of the tapes, helically applied like the felted asbestos to assure perfect and permanent centering of the conductor in the insulation.



Now unwind the varnished cambric tapes (c) which will peel easily, and you'll see the obvious advantage of multi-layer tape application—*not one thickness, but many.* And under the tapes you'll also see a second felted asbestos wall (d) the inner heat-barrier which completes the protection of the varnished cambric.



Finally, slit and peel back this felted asbestos wall (d) which prevents conductor-heating overloads from breaking down the varnished cambric and won't burn even when exposed to copper-melting arcs, and you'll see the paper separator (e) that keeps the conductor clean of insulation and makes stripping easy. And that completes the story of Rockbestos A.V.C. *the wire with permanent insulation.*

Two important factors govern the selection of wire and cable for "hot-spot" service in steel mills, power plants and various vital industries. First, the conditions under which the circuits must operate, such as around soaking pits, boilers, furnaces, steam lines, drying ovens, rheostat grids; places where resistance to heat and moisture, corrosive fumes, oil, grease and even fire is essential. Second, and most important, is the construction of the wire—its in-built ability to stand up under these severe conditions.

Rockbestos A.V.C. Power, Motor Lead and Lighting Wires and Cables (National Electrical Code, Type AVA) meet the requirements of "hot-spot" service with permanent insulation that won't bake brittle, crack, bloom, swell or rot and has a maximum operating temperature rating of 110° C. (230° F.).

Apply the knife-test to a sample of Rockbestos A.V.C. and you'll find the answer to production losses and unnecessary maintenance due to wire-failure beneath the braid. Send for a sample and dissect it yourself. Rockbestos Products Corporation, 981 Nicoll St., New Haven, Conn.

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

122 different permanently insulated wires, cables and cords

developed by Rockbestos for various severe operating conditions

NEW YORK, BUFFALO, CLEVELAND, CHICAGO. PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

ago as assistant general manager of sales after having been with Bethlehem Steel Company for 22 years. Born in Kingston, New York, he was graduated from the Kent School in 1918, and from Princeton University in 1922. During World War I, he served in the Army and became an officer in the Field Artillery Reserve Corps.

R. O. Herbig, since 1921 district sales manager in Chicago for The Reliance Electric and Engineering Company, Cleveland, has been appointed central western sales manager of the company. The new position extends Mr. Herbig's activities to include the territory westward to Denver and is part of the company's program of enlarging responsibilities in line with expanded business.

R. O. HERBIG

Mr. Herbig came with Reliance in 1917 following his study of electrical engineering at Case School of Applied Science and has been with the company since except for a period of service in World War I. He opened the first Reliance office in Cincinnati in 1920 and became manager in the Chicago District in 1921, where he has been particularly active in application work in the steel, machine tool and paper industries.

Howard A. Byrns has been appointed chairman of the blast furnace, open hearth and coke committees of the American Steel and Wire Company, Cleveland, Ohio. At the same time, **Harold Cope** has been made general superintendent of Central Furnaces and Coke Works, succeeding Mr. Byrns.

Mr. Byrns is a native of Cleveland, Ohio, and attended the public schools of Cleveland before enrolling at Case School of Applied Science, from which he was graduated in mechanical engineering. His only employment has been with U. S. Steel subsidiaries. He started with the American Steel and Wire Company, in August, 1923, as a machinist at Central Furnaces, and progressed to assistant superintendent of that plant in May, 1929. From May, 1933 to September, 1936, he was assistant superintendent at the Lorain, Ohio, Works of National Tube Company and the following year was transferred to the Duluth Works of American Steel and Wire Company as general superin-

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Why they insure full, quiet, and dependable power-flow.
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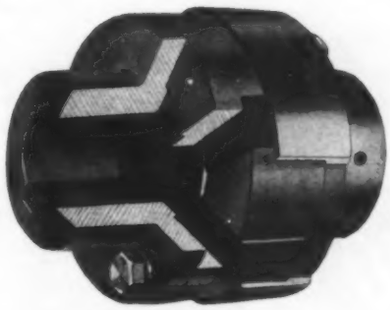

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Illustrates L-R construction principle: Free-floating resilient load cushions *instantly* adjusting to any emergency, hung between rugged jaws. Electric steel castings, and greater number of jaws for load carrying capacity. Cushion materials adapted to particular duty. Metal jaws drive even after cushions are worn. Cushions always in sight. NO SHUT-DOWNS for changing. No lubrication needed.

Send For Catalog, with Quick-Finding Selector Charts.

Charts lead you right to couplings required without tedious figuring. Catalog shows couplings for duties from 1-6 to 2500 h.p. Special couplings engineered. Write or wire.

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tendent of the steel works. In September, 1940, he was transferred back to Cleveland as general superintendent of the company's Central Furnaces and Coke Works.

Mr. Cope was born in Leechburg, Pennsylvania, and attended Pennsylvania State College where he majored in industrial chemistry, metallurgy and industrial engineering. He has worked for American Steel and Wire Company since June, 1910, when he was employed in the engineering department at Donora steel works. He held several positions there and at Newburgh Works in Cleveland before being named superintendent of blast furnaces at the Donora works in April, 1934. In August, 1940, he was promoted to assistant general superintendent of that plant and in June, 1942, was transferred to Cleveland as division metallurgist, blast furnaces and steel mills, which position he now relinquishes to assume his new duties.

William Rodgers, formerly chief metallurgist of the Cleveland district of Republic Steel Corporation, has been made assistant superintendent of the 98 in. strip mill and **T. M. Chapman,** as chief metallurgist, succeeds Mr. Rodgers.

Born in Pittsburgh, Mr. Rodgers attended high school in Erie, Pennsylvania, and later went to Carnegie Tech and the University of Pittsburgh. He received the degree of metallurgical engineer at Pittsburgh in 1928.

His first job was with the Erie Forge and Steel Company as a chemist while he was still in school. He next went to Carnegie-Illinois Steel Company at Duquesne where he worked in the open hearth. At United Alloy Steel Company, Canton, he was in the open hearth, electric furnace and blast furnace departments.

He later joined the South Side Plant of Jones and Laughlin and from there went to the Halcomb Steel Company at Syracuse, New York, as a metallurgical engineer. He was with Donner Steel Company as a metallurgist when it became a part of Republic, and came to Cleveland in 1940.

Mr. Chapman was born in Cleveland, attended Glenville high school and graduated from Case School of Applied Science with the degree of bachelor of science in 1927. In 1930 he received the degree of metallurgical engineer.

His first employment was at the Bourne Fuller Company as a shear helper. He later joined the Corrigan-McKinney Steel Company as a temper man and observer, and from 1927 to 1932 was a staff member in the research department of the National Malleable and Steel Castings Company.

From 1933 to 1935 he was with Cold Metal Process Company doing silicon steel research and Steckel mill design. He came with Republic in the Cleveland district in 1935 as a general metallurgist.

Franklin R. Hoadley has been elected president of Farrel-Birmingham Company, Ansonia, Connecticut. Mr. Hoadley has been associated with Farrel-Birmingham Company since his graduation from Yale University in 1914. During World War I he served as a lieutenant in the ordnance department. Returning to Farrel-Birmingham in 1918, he became foundry manager in 1919, and in 1930 was elected vice president and a member of the executive committee. He has been a

Axial section of an IMO pump

Lubrication oil pump directly connected to shaft of steam turbine.

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The IMO pump provides "more pump in less space" because it can be operated at high speeds and correspondingly high capacities, directly connected to and integrally mounted upon motors, turbines or other driving machinery—without the necessity of speed reduction gears.

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director continuously since 1923. For the past eight years Mr. Hoadley has been president and treasurer of The Atwood Machine Company, Stonington, Connecticut, which has been purchased by Farrel-Birmingham Company, and Mr. Hoadley will continue general supervision of this plant, as well as assuming general management of the company's other three plants in Ansonia and Derby, Connecticut, and Buffalo, New York.

S. B. Heppenstall, since 1917 the vice president in charge of engineering has been elected chairman of the board of directors of The Heppenstall Company. Mr. Heppenstall, the second son of Sam Heppenstall, company founder, joined Heppenstall Company as a draftsman in 1897. He has always been concerned with engineering activities and many of the improvements made through the years in Heppenstall mechanical equipment are attributed to his ingenuity.

Joseph C. Jones and **Leonard A. Yoder** have organized the firm of Jones and Yoder, with offices in Cleveland, Ohio, New York, New York, and Philadelphia, Pennsylvania.

The firm's activities will be directed to the engineering and supply of equipment for the working of metals and plastics by slitting, rolling, drawing and press methods, with emphasis on the producers of plastic, steel, aluminum, brass and copper and on the fabricators of their materials. It now represents, among others, the Yoder Company of Cleveland, and the Elmes Engineering Works of American Steel Foundries, Chicago, Illinois. The firm will cover the eastern seaboard from New England through Maryland including eastern Pennsylvania.

Allen Robinson has been appointed head electrical engineer of American Steel and Wire Company, subsidiary of U. S. Steel Corporation, and **Clare L. Becker** has been named assistant electrical engineer. Both men will be located in the Cleveland office.

Born in Ponca, Nebraska, on November 10, 1895, Mr. Robinson attended Sioux City public schools before matriculating at Iowa State College, from which he was graduated in electrical engineering. He has been employed by the American Steel and Wire Company since February, 1923, when he was hired as an electrical engineer in the Pittsburgh district. In 1927, he was transferred to Donora, Pennsylvania, where he held a number of positions in the Steel and Wire Works before being named superintendent of engineering and maintenance in April, 1944.

Mr. Becker was born in Amherst, Ohio, on May 10, 1904. His first employment with the Wire Company was at the Cuyahoga Works in Cleveland when he was hired as works engineer in October, 1930. He has held a number of positions with the company and since November, 1943, has been section head draftsman.

George C. McMullen has been appointed assistant to the president and vice president in charge of product research and development for Tyson Bearing Corporation, Massillon, Ohio. For many years a vice president in charge of industrial sales, he will use his broad knowledge of industry's bearing requirements for the development and improvement of Tyson products.

Steady Service— Long Life— From Portable Tools

Foremost makers* recommend the use of NON-FLUID OIL after determining by prolonged service tests that it helped their tools perform most efficiently over long periods.

What's more, NON-FLUID OIL not only reduces maintenance and repair cost, but saves money on lubricant and labor expense because it lasts longer.

NON-FLUID OIL is being used successfully in leading iron and steel mills. Send for instructive bulletin.

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Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

Harry L. Vines has been named director of sales for Tyson Bearing Corporation at Massillon, Ohio. He will supervise sales operations in an expanded program which will give Tyson bearings nation-wide distribution in the automobile, industrial and railroad fields. Formerly western manager for R. G. LeTourneau, Inc., Stockton, California, he has had extensive sales management experience, first with Master Equipment Company, then with Caterpillar Tractor Company before joining LeTourneau in 1940.

William H. Colvin, Jr., has been elected president of Crucible Steel Company of America, succeeding **Joseph H. Callan,** who resigned as president to become chairman of the company's executive committee. Until his election as president of Crucible, Mr. Colvin was president of Rotary Electric Steel Company, a position occupied by him for nine years. He was one of the founders of that business in 1933.

Obituaries

Frank D. Egan, superintendent of Bethlehem Steel Company's electrical department at Lackawanna, New York, died February 17th. Mr. Egan had been on a leave of absence from his duties for the past two years because of poor health.

Born in Frostburg, Maryland, Mr. Egan was graduated from University of Pittsburgh in 1910 in electrical engineering. He worked successively at National Tube Company at McKeesport, Carnegie Steel Company at Homestead, and Westinghouse Electric and Manufacturing Company at East Pittsburgh, before moving to Crucible Steel Company, Midland, Pennsylvania in 1918. In 1923 he moved to Buffalo, and was associated with Bethlehem since that time.

Mr. Egan was a past president of the Association of Iron and Steel Engineers and served as chairman of its tandardization committee for many years.

William Clifford Young, a member of the rolls sales staff of the Lewis Foundry and Machine Division of the Blaw-Knox Company, died in St. Elizabeth's Hospital, Youngstown, Ohio, on February 5. He was 67 years old.

Mr. Young was born in Salem, Ohio, and began his career in a tin plate rolling mill in Monessen, Pa. He was a resident of the Pittsburgh district for more than 40 years, and since 1918 was associated with the Lewis Foundry and Machine Division.

Huntington Downer, sales manager of Basic Refractories, Inc., Cleveland, Ohio, died February 11 at Fort Lauderdale, Florida. He was 57 years old. He had gone to Florida in December to regain his health following an operation.

Mr. Downer had been associated with the steel industry for the past 35 years. After his graduation from Yale University in 1909, he was connected with the Lackawana Steel Company until 1922. After a short period with the Iron Trade Products Company of Pittsburgh, in 1923 he joined the Basic Refractories' organization with whom he was associated until his death.

Ralph J. Edmiston, sales engineer with the United States Graphite Company, Saginaw, Michigan, for 27 years, died January 28th in Pittsburgh, Pennsylvania. Mr. Edmiston, widely known in the steel industry was born in New Lexington, Ohio, 1882.

FRANK D. EGAN

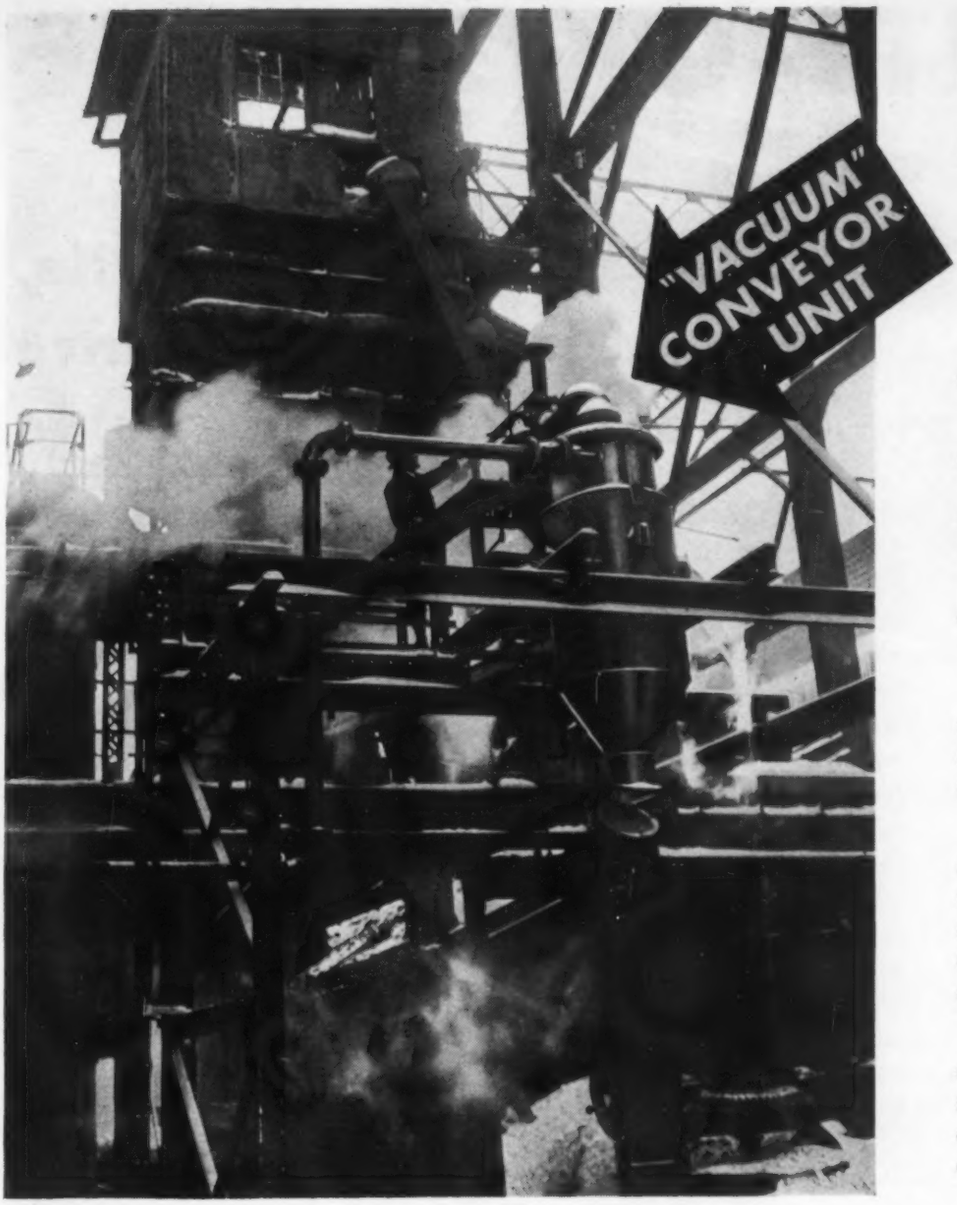
Ernest J. Poole, Jr., 48, vice president in charge of manufacture and a director of The Carpenter Steel Company, Reading, Pennsylvania, died February 19 in that city. He was a graduate of the U. S. Naval Academy at Annapolis, and entered the employ of the company in 1922. He succeeded his father, **E. J. Poole, Sr.** as vice president of the company upon the latter's death in 1937.

Harry K. Maxwell, roll shop superintendent at Saucon plant, Bethlehem Steel Company, died February 21. Born in Aberdeen, Maryland, Mr. Maxwell attended special night courses at Lehigh University, and in 1910 entered the employ of Maryland Steel Company, at Sparrows Point, Maryland, as a roll turner apprentice. After two years, he went to Bethlehem Steel Company at Bethlehem, Pennsylvania, where he completed his apprenticeship as a roll turner. In 1917, he left Bethlehem and became associated with the Cambria Steel Company at the Steelton plant, and later accepted a position with the Pittsburgh Rolls Corporation.

During World War I, he entered the armed forces and after brief service, was transferred by the U. S. Army to the Shipyard Division at Sparrows Point where he supervised the laying out of ship plates.

Following the war he entered private business until 1922, when he returned to the Bethlehem Steel Company as a roll turner in the Saucon plant.

In 1926, he assumed charge of the piece rate work in the Saucon roll shop and in 1928 he was appointed superintendent of the Saucon plant roll shop and served in that capacity until his death.



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Furnace Flues
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IN LESS TIME
AT LESS COST
WITH LESS LABOR
MORE EFFICIENTLY

We have taken one of the most disagreeable, dirty, back-breaking jobs around a Steel Plant and made it a simple, routine piece of work.

Instead of allowing flue dirt to collect until a furnace must be shut down and the flues cleaned out, you can remove and convey dirt away with the Vacuum Conveyor continuous System, as it accumulates.

It *keeps* flues clean, which means no delay in heating time. And, clean flues eliminate any increase in fuel consumption at a later period in the campaign of the furnace run.

Here is the 36″ x 72″ Vacuum unit, Model 105X with Secondary Cyclone, at work. Installed in the Wickwire Spencer Plant, Buffalo, N. Y., this unit pulled the flue dust and producer gas dust from an open hearth furnace.

What the Vacuum Conveyor is doing for a long list of prominent steel companies, it can do in *your* plant. Since no two plants are alike, our engineers, if given a layout of your present facilities, can adapt the Vacuum system to your individual plant. Write today, for bulletin. It describes Vacuum units and includes testimonials of satisfied users.

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...a versatile, low-maintenance cable for all-around service

One important cost-reducing step towards lower maintenance is the selection of long-lived electrical cables. When Okolite-Okoprene cables are specified, engineers are assured of a product proved in service with millions of feet installed . . . under every operating condition including wide and varied service in the metal-producing industries.

Okolite-Okoprene cables (U. S. Patent 2,312,-058) may be installed in ducts, buried directly in the earth and exposed to the elements *without additional protection.* Simple to handle, splice and terminate, they are designed in all standard sizes and many colors for service up to 5000 volts.

Briefly summed up at the right are the principal features of Okolite-Okoprene cables including the electrical and physical operating advantages and advantages in installation.

Okonite engineers are always ready to help you. With their long experience in the electrical field, their viewpoint is especially useful when it is joined with that of your own engineers in discussing problems of elctrical distribution.
The Okonite Company, Passaic, New Jersey.

PATENTS PROTECT JOBS — LET'S PROTECT 'EM

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ADVANTAGES IN DESIGN

1. Simple construction
   a. No tapes or braids
   b. No metallic coverings
2. Insulated by Strip Process
   a. Perfectly centered conductors
   b. Uniform thickness of Okolite insulation
   c. Uniform thickness of Okoprene covering
3. Vulcanized in a continuous metal mold
   a. Tough, dense covering
   b. Uniform vulcanization throughout length

OPERATING ADVANTAGES — ELECTRICAL

Okolite Insulation

1. Ozone resistant
2. High dielectric strength
3. Stable electrical characteristics
4. Low specific inductive capacity
5. High current carrying capacity (75° C copper temperature)

Okoprene Covering

1. Additional dielectric strength
2. High surface resistance eliminates charging current drainage from surface of cable
3. Ozone resistant

OPERATING ADVANTAGES — PHYSICAL

1. No braids to rot
2. High moisture resistance
3. Resists oil and solvents
4. Resists acids, alkalies and corrosive chemicals
5. Non-flammable covering
6. Can be operated at 75° C
7. Unaffected by sunlight
8. Weatherproof
9. Long-lived

ADVANTAGES FOR INSTALLATION

1. No potheads required
2. Easy to splice
3. Light weight
4. Small outside diameter
5. Smooth, snag-proof covering
6. Easy to pull into ducts
7. High abrasion resistance
8. High tensile strength sheath
9. Flexible at low temperatures
10. No saturants to soften in heat or flake off in cold weather
11. Can be bent on small radius

OKONITE insulated wires and cables

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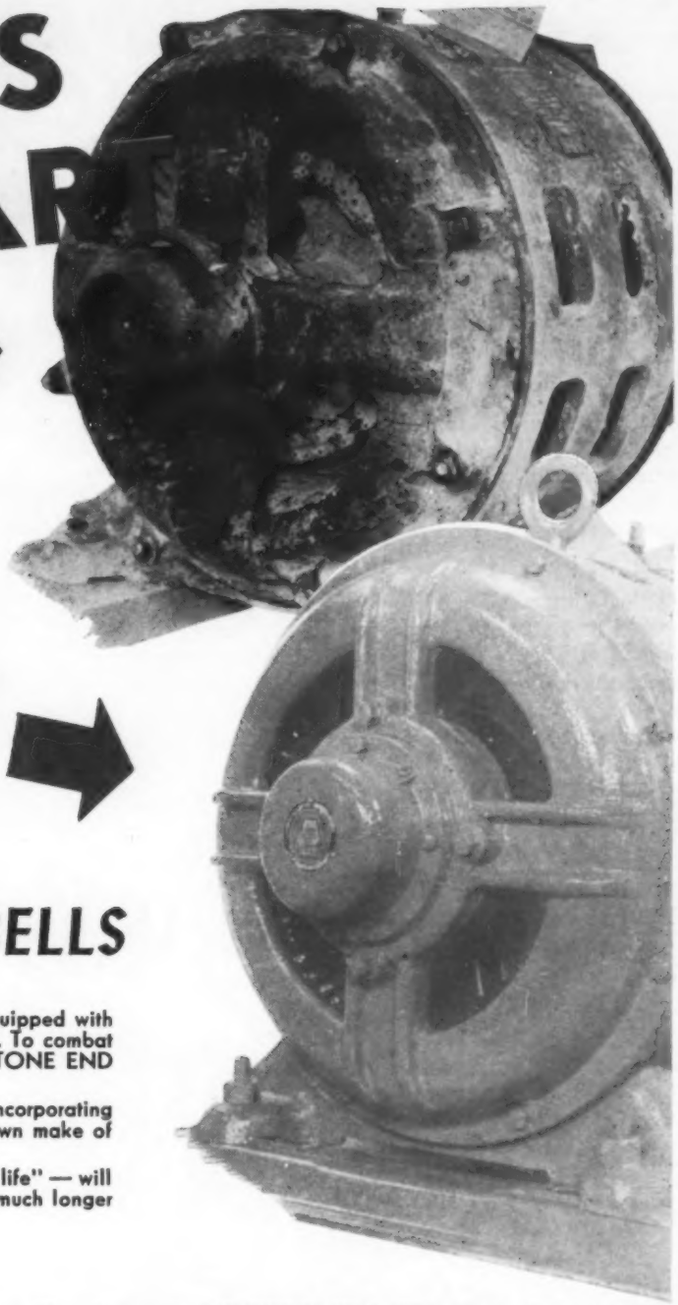

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with KEYSTONE END BELLS

In many industries the damage done by dirt and dust to motors equipped with oil lubricated sleeve bearings, account for half of the motor failures. To combat and end, with absolute certainty, this common trouble, the KEYSTONE END BELL was developed.

The KEYSTONE END BELL is a *sealed, grease-packed unit* incorporating ball bearings . . . designed to fit (without machining) any well-known make of motor, in any size or type.

The KEYSTONE END BELL will give motors a new "lease on life" — will help you keep valuable and critically scarce equipment in service much longer than in the past!

Maintenance men will welcome the KEYSTONE END BELL for it eliminates the lubrication of sleeve bearings — keeps oil from the commutators and mica cone. The KEYSTONE END BELLS are easily installed and if it becomes necessary to dismantle the motor, remove the rim bolts and the four cap screws at the center hub and the end bell slides off, leaving the bearing housed in the cartridge.

A folder giving complete information and specifications is available for your use, write or call us.

THE OHIO BALL BEARING CO.

6531 EUCLID AVE. **CLEVELAND, OHIO**

WHAT'S DIFFERENT ABOUT YOUR BILLET SHED ?

THERE'S more than one way to skin a cat . . . that's our American way of saying that jobs that have to be done can be done differently than in the past. A good example for steel men is the striking advance in billet-cleaning practice made possible by mechanization. Today some companies have installed as many as nine Billeteers to mechanize billet conditioning. Why, when these investments prove so universally profitable, do some other mills still cling to manual chipping?

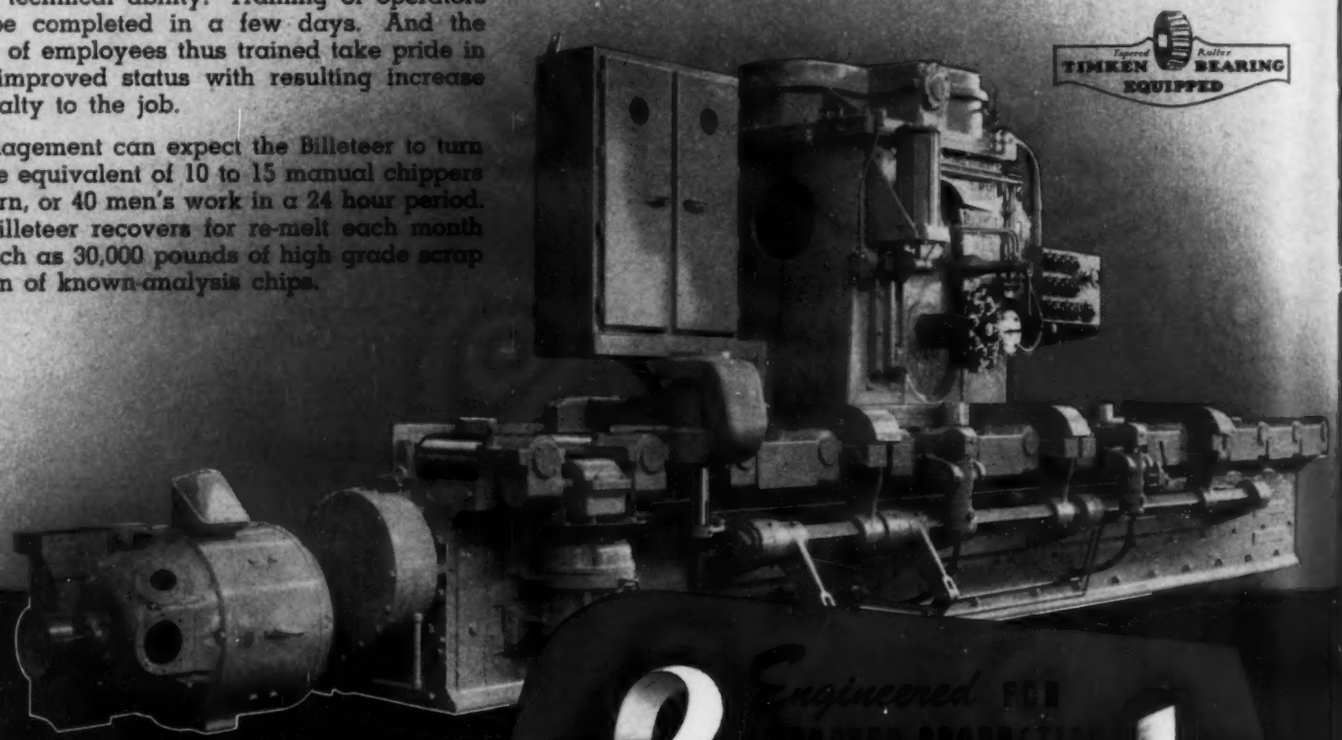
• There may be some hesitancy because management has not fully realized that labor opposes mechanization only when fears arise of the threat to a man's livelihood. Today alert labor welcomes machines as a means toward greater production and increased earnings.

• Billet chipping is a nerve-wracking job; a man-killing job. The extreme labor turnover in billet sheds proves that there is a limit to human endurance. Labor is asking "Why kill yourself to earn a living?" Labor is ready to accept such machines as the Billeteer which alleviate fatiguing toil.

• Billeteers make billet chipping a semi-skilled operation. The machine does not require exceptional technical ability. Training of operators can be completed in a few days. And the group of employees thus trained take pride in their improved status with resulting increase of loyalty to the job.

• Management can expect the Billeteer to turn out the equivalent of 10 to 15 manual chippers per turn, or 40 men's work in a 24 hour period. The Billeteer recovers for re-melt each month as much as 30,000 pounds of high grade scrap in form of known-analysis chips.

• What greater combination of service and economy, both in direct and accompanying factors, could you bring to your billet shed? Write Bonnot for illustrated booklet and reference to executives whose plants use Billeteers. Address Steel Equipment Division.



MECHANIZE YOUR BILLET CONDITIONING NOW. PREPARE FOR TOMORROW'S INTENSIFIED COMPETITION.

Engineered for Improved Production

Bonnot

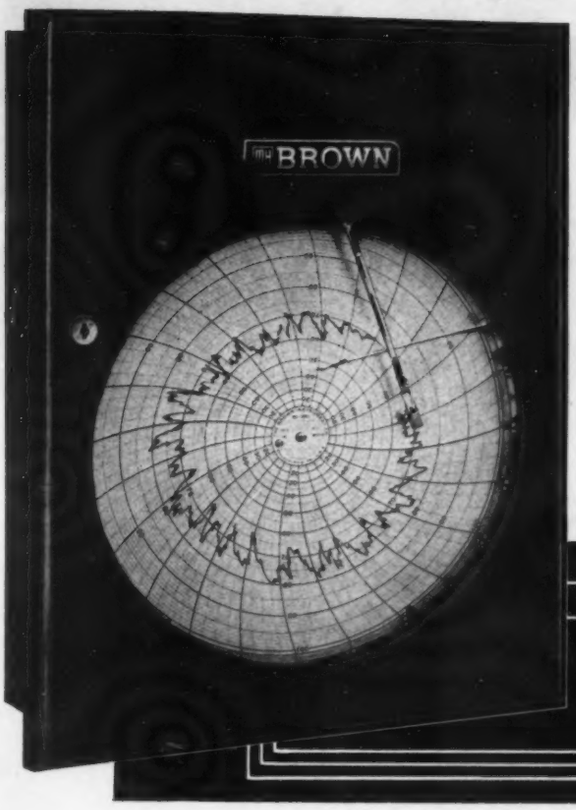
THE BONNOT COMPANY

BUILDERS OF **THE BILLETEER**

CANTON 2, OHIO

ADDRESS CORRESPONDENCE TO

STEEL EQUIPMENT DIVISION



For Remote Metering of TARS, CHEMICALS, HEAVY OILS DISTILLATES

Records and Indicates Rate of Flow at any Distance

HERE'S a flow meter that indicates or records at a distance, if desired, the "rate of flow" of anhydrous ammonia, and concentrated sulphuric acid, etc., as well as tars, heavy fuel oils, distillates. Easy to install, it has no stuffing boxes or pressure tight bearings. In its installation no orifice plate or venturi tube, no tubing, valves, seals, mercury and complex piping is required. It is unaffected by dirt and functions without constant attention.

Meter body goes in the line like a valve.

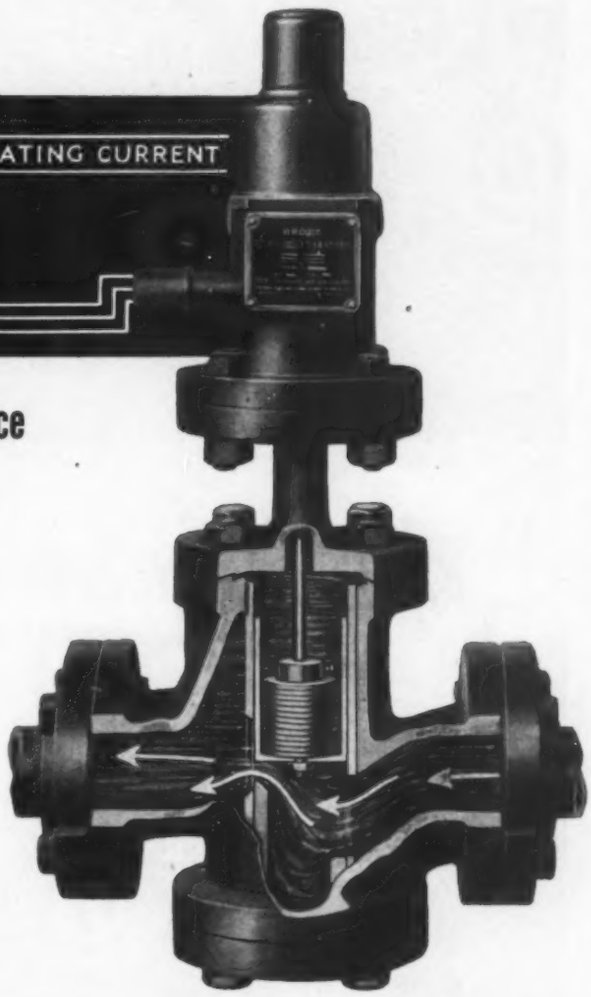
Electrical transmission permits the Indicating or Recording meter to be located at any distance from the meter body.

The flow is recorded in units, of gallons, barrels, cubic feet or pounds per hour on a 12" circular chart, equally graduated.

The Brown Area Flow Meter operates on the fundamental principle of all area meters — the flow is proportional to the area of orifice exposed. Combined with this principle is the exclusive feature of the Brown Electric Flow Meter — the Inductance Bridge Principle.

In many plants The Brown Area Flow Meter has demonstrated its value as an aid to economy and increased production.

For information write THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Company, 4464 Wayne Avenue, Philadelphia 44, Pennsylvania. Offices in all principal cities, 119 Peter Street, Toronto, Canada — Wadsworth Road, Perivale, Middlesex, England — Nybrokajen 7, Stockholm, Sweden.



GOES IN THE LINE LIKE A VALVE

The Brown Area Flow Meter maintains a constant differential by varying the area of the orifice. Example: As the flow increases the weighted piston rises and exposes more orifice area.

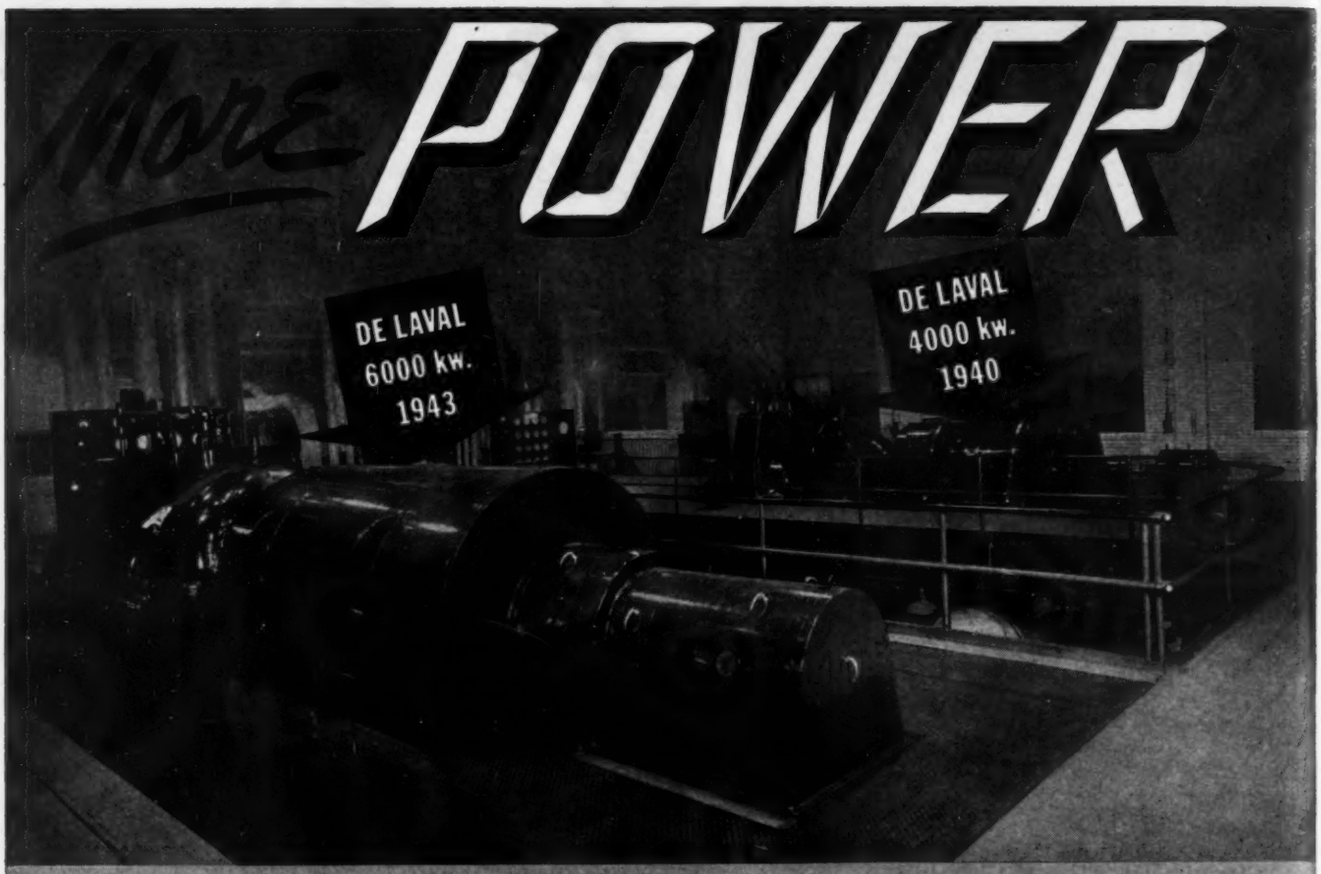
The orifice is a rectangular slot cut in the sleeve in which the piston slides. While the weight of the piston is fixed for a given installation it can be readily changed to meet new conditions.

The operating parts may be made of bronze or steel as conditions indicate.

BROWN AREA FLOW METER

on the Inductance Bridge Principle

More POWER



for Wyandotte — SECOND DE LAVAL TURBO-ALTERNATOR INSTALLED FOR MODERN MUNICIPAL STATION

Power for the City of Wyandotte, Mich., is generated in part by two DE LAVAL turbo-alternators . . . a 6000 kw. and a 4000 kw. unit; the older unit having been installed in 1940 and the newer unit in 1943. The excellent performance of the first De Laval unit influenced the purchase of the second. • Both units are so arranged that oil pumps and oil lines are isolated from high temperature steam to eliminate fire hazards. • The De Laval Steam Turbine Company is one of the oldest builders of steam turbines and their experienced engineers are prepared to discuss your requirements without obligation.

3529

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

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STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

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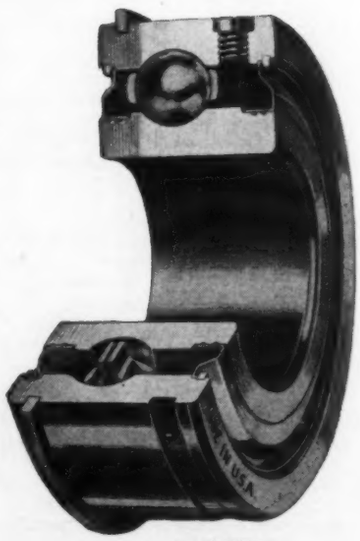
THAT EXTRA SOMETHING...

FOR THE LONG, HARD PULL

IN AN ATHLETE, it is called "STAMINA." In a ball bearing, it is DURABILITY—and it is determined by the inbuilt features that safeguard against wear and break-down.

The NORMA-HOFFMANN "CARTRIDGE" BALL BEARING has all these vital features, developed to the last degree:—wear-less, friction-free, all-metal seals (removable and replaceable) sealing lubricant in and dirt out, regardless of shaft angle; at least double the grease capacity of any other single-row bearing. A design that holds the grease ON THE ROLLING SURFACES, where it is most effective.

Read about these, and other, valuable features of the NORMA-HOFFMANN "CARTRIDGE" BALL BEARING in the Catalog, sent on request. Or, ask our nearest office to have one of our Field Engineers call and explain.



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STAMFORD, CONNECTICUT ★ Founded 1911

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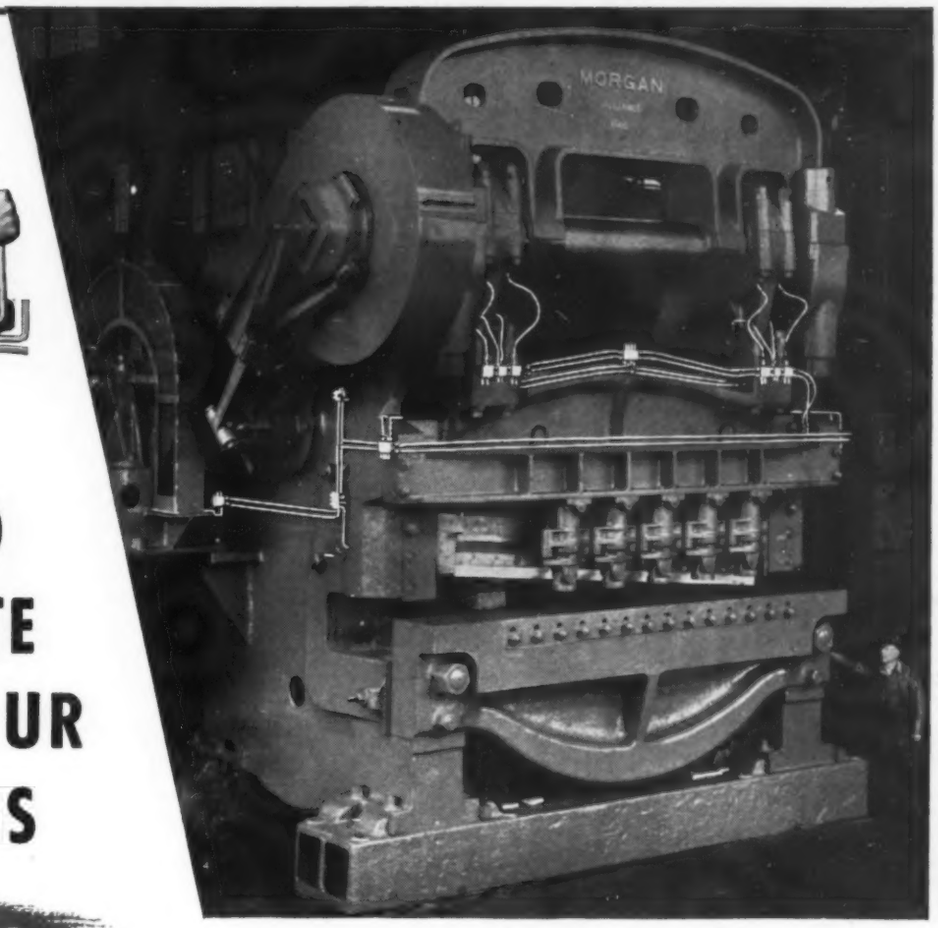

HOW TO LUBRICATE ALL OF YOUR BEARINGS

at once —and increase your output

Your production and your profit go down, every time one of your machines goes down for the want of proper lubrication.

Whatever *your* equipment, the Farval Centralized System will eliminate down time to lubricate or to repair the lack of lubrication. Because Farval will *always* deliver the proper amount of oil or grease under pressure to *all* of your bearings, on *all* of your machines, *all* of the time—missing none.

Farval costs but little to buy and install—it begins earning from the first hour and will add years to the life of the equipment it serves. Farvalize in '45 and increase your profit. The Farval Representative near you will help you to apply the correct Type.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

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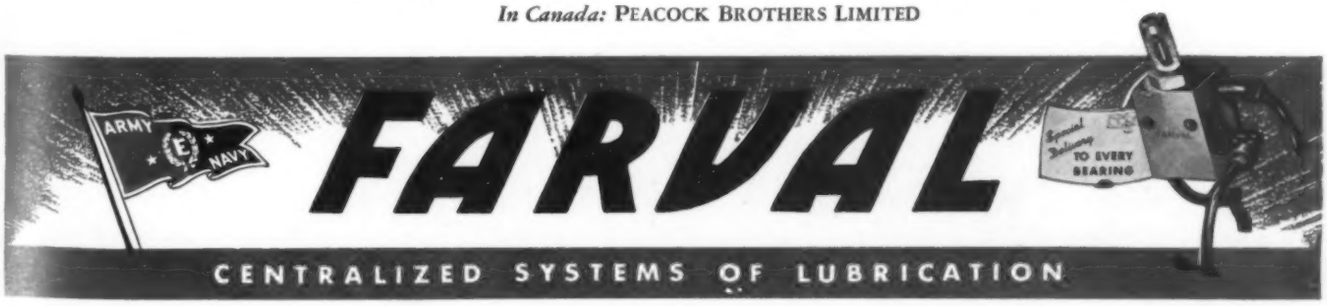
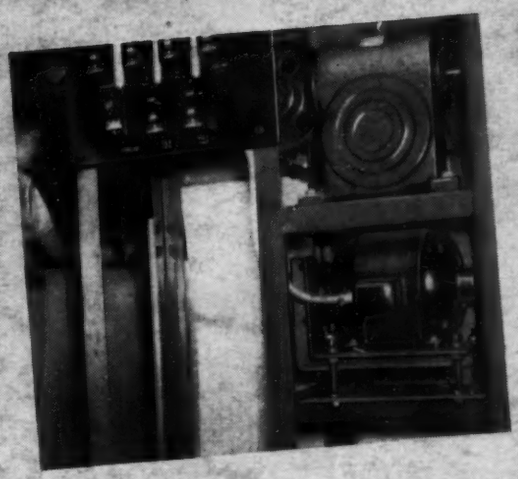


IN STUFFY SPOTS

Many a motor must be located where walls, adjacent equipment, or materials cut down the free flow of air. Sometimes, as in the case of this wool-dryer drive, surroundings are hot, and stuffy, too.

Tri-Clad motors have proved themselves cool-running even under such conditions. Their powerful, double-end ventilating system moves the air at controlled velocity for effective heat removal. The location and baffling of dual exhaust ports discourage recirculation.



Tri-Clad motor drives conveyor on wool dryer—Bigelow Sanford Carpet Co., Amsterdam, N. Y.

AIR-FLOW TESTS OF TRI/CLAD MOTORS LEAD TO PROTECTION FROM OVERHEATING

Plenum chamber test of Tri-Clad motor ventilation at G-E motor factory.

Before new types or sizes of Tri-Clad motors are approved for production, plenum chamber tests are conducted on the ventilating systems of sample models. These measurements serve as a check on previous calculations of the volume and velocity of air through the motor under different conditions. Other tests under load within enclosures and at abnormal ambient temperatures are also made. If your motors must be confined in stuffy spots, G.E. can help you make the right choice to beat the heat. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

TRI/CLAD MOTORS

Buy all the BONDS you can—*and keep all you buy*